SOME ASPECTS OF THE VISUAL SEARCH AND SCANNING BEHAVIOUR OF SCHIZOPHRENICS

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Robert Gerald Knight
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ABSTRACT

Some measures of scanning and search behaviour are explored, and their relation to the postulated attention deficit of schizophrenics is investigated. The tasks used required Ss to scan multielement displays and to either respond to a predefined target, or to make a same-different decision. The primary experimental manipulations involved varying stimulus complexity, defined both in terms of numbers of elements, and stimulus structure. The results suggested that scanning rates do not differ between controls and schizophrenics, over a range of stimulus complexity, although there is a significant tendency for the patients (especially the older, long term Ss) to have a constant, slower RT. This implies that slow schizophrenic RT may be more largely determined by response organization and execution, rather than stimulus input processing. These results are discussed in the context of methodological problems, research on the attention processes of non psychiatric Ss, and current notions of cognitive functioning advanced by the schizophrenic deficit theorists.

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INTRODUCTION

Attention is a concept with a diverse history. After the early popularity of the study of attention with the introspectionists, the positivistic behaviourists, and the Gestalt psychologists successfully dismissed this whole notion from their theoretical considerations. By the late 1950s however, with the expansion of interest in cognitive psychology and information processing models, attention, in many guises, had become the concern of many experimental and psychological theorists. This has led gradually to the conceptualization of attention in the context of information handling structures and mathematical models, which have offered more rigour and methodological precision in the measurement of selective attention.

Similarly, for the last twenty years, a developing literature has been concerned with the understanding of the cognitive dysfunctions coinciding with the onset or exacerbation of psychiatric disturbances. In particular, the study of schizophrenic deficit has been prolonged and detailed. Much of the productive work in this area has resulted from the grafting of cognitive theories of attention on to the comprehension of the hypothesized processing deficit concomitant with schizophrenic disturbances. This thesis follows the tradition established by some of the foremost workers in the field, McGhie (1969), Neale (1971), Shakow (1972a) and Yates (1973) in relating cognitive deficit to the work done by attention theorists such as Kahneman (1973), Neisser (1967) and Treisman (1969). For this reason relevant areas of attention research are reviewed briefly in the first chapter and the concepts introduced at this point are related, where possible, to the literature on schizophrenic cognitive functioning presented in Chapter 2.

The particular line of experimentation which is to be followed in the two major studies reported in this thesis (Chapters 5 and 6) concerns scanning or search behaviour in chronic or process schizophrenics. It will be apparent that such a research project involves only the limited aspect of possible attention deficit where attention is operationally defined as the ability to scan visual material, in this case letter elements, for a target element and to then make a response appropriate to the task requirements. The primary experimental manipulation involved varying the levels of stimulus complexity or stimulus uncertainty (Smith, 1968). Process schizophrenics (the definition of the subcategories of schizophrenia is discussed in the second part of Chapter 2) were used primarily because they constitute a sizeable majority of hospitalized patients, and they also commonly report attentional difficulties (Chapman and McGhie, 1961). Such patients are not easily assimilated into the community and consequently any delineation of their cognitive defects is potentially of considerable importance in aiding their transition from hospital to normal living.

In selecting control groups, two approaches are evident in the literature. One is to argue that experimenters should be concerned with schizophrenic deficit as a specific cognitive disturbance not shared by other psychiatric groups. The other approach is to regard such a study as an attempt to examine chronic schizophrenics and the way they achieve or approximate normality, with the limited goal of concern being only these patients - their prognosis and treatment. The latter approach has been used in this thesis. This has been justified by claiming that; (a) it is necessary to show that attentional deficit can be measured by the task used with a particular patient group before moving to attack the specificityof this dysfunction, and (b) all that can usually be deduced from data is the <u>extent</u> to which a deficit varies over a number of groups and not necessarily the specificity of the deficit per se. It is also pertinent that a normal baseline is of considerable theoretical importance if the attention defect is conceptualized in terms of effort or limited capacity (Kahneman, 1973; see also conclusions, Chapter 2). This type of theorizing (Kahneman, 1973;

Rabbitt, 1968) acknowledges that there is no compelling reason for the locus of cognitive deficit to be specific, even if a syndrome is clearly differentiated from every other psychiatric disorder.

Although schizophrenia has been described since the time of Hippocrates, and has attracted the interest of many emminent workers in the psychiatric field (e.g., Bleuler, 1911: Haslam, 1809; Kahlbaum, 1874; Kraeplin, 1899; Pinel, 1801), the validity of the concept has often been called to question. How meaningful then is the diagnosis of schizophrenia upon which the plethora of schizophrenic deficit literature is baded? Many workers in the field, particularly those involved in psychotherapy or behaviour modification have decried the traditional nosology ponderously constructed by Kraeplin (1899), subsequently modified by Bleuler (1911), and enshrined seemingly forever in the International Classification of Diseases (ICD, 8th edition, officially adopted by the N.Z. Health Department in 1968). Some practitioners have found the concept of schizophrenia unnecessary. Altschule (1970) for example notes that the word "schizophrenia" will "...probably last forever for two reasons. One is that it is meaningless, and the other is that it is eupohonious (p. 86)." Nevertheless continued use of the diagnosis has been vigourously defended as an heuristic hypothesis. Clinicians from all over the world tend to regard overt symptomatology in much the same way. When they agree to use rigidly defined stereotypes, agreement between psychiatrists can reach eighty percent, (Beck, 1962; Hordern, Sandifer, Green and Tinbury, 1968). There is however more difficulty in establishing the finer subcategories of diagnosis (Nordern et al. 1968; Lorr and Klett, 1968; Morgan, Brozio, and Hedlund, 1968). The usefulness of schizophrenia as a word to describe a certain set of symptoms has been very generally accepted, and Kety (1970) probably speaks for a majority view when he states that:

> "Someone once said in reply to the controversy about whether Homer had really written the Illiad, that it wasn't Homer, but someone else with the same name. I really think one can finesse the question of whether schizophrenia exists. I find it very compelling that independent observers looking at a variety of individuals can come up with agreement that certain people differ from the rest and that they differ according to certain characteristics (p. 278)."

Finally, what is meant by the "cognitive approach to schizophrenia," and what role may the cognitive psychologist play in the study of schizophrenia. Clearly, at this stage, in contrast to biochemical, psychodynamic and motivational theories, cognitive psychological research does not offer any direct therapeutic benefits, and only some tenuous notions concerning psychophysiological function which might be interpreted as pertaining to the aetiology of schizophrenia. The cognitive theorist's primary aim is to define and hence measure thought disorder, and to do this, he conceives of man as an information processor, an entity who classifies, encodes, memorizes or attenuates stimulus input. Buss and Buss (1969) explain that a cognitive theorist may invoke a number of aspects of cognition to explain schizophrenia:

> "He may focus on associations, for it has been clearly demonstrated that schizophrenics have associative disturbances: or he may focus on concepts, for it has been clearly demonstrated that schizophrenics have conceptual disturbances. But underlying these two kinds of cognitive dysfunction is a more fundamental defect of attention - the ability to maintain a set and keep out distracting stimuli. In recent years investigators who view schizophrenia in terms of cognitive dysfunction have increasingly endorsed the notion that attention is the key to understanding schizophrenia (p. 12)."

Attention then is a dominant theme in any evaluation of schizophrenic disturbance, and is in itself a concept of considerable complexity, difficult to meaningfully define. Therefore, before turning to a survey of the studies which have focused on information processing in schizophrenia, it is important to take a critical view of the meaning experimental psychologists have attached to "attention".

CHAPTER ONE

MODELS OF HUMAN SELECTIVE ATTENTION & SCANNING BEHAVIOUR

> "...attention is a topic which has lately been neglected, but which was of great weight in textbooks of an earlier time. It is one of the most obvious features of human behaviour, and the principles which govern it should certainly form a part of our basic theoretical knowledge. It fell into bad odour because of the inability of introspective psychologists to agree with one another, or to provide objective evidence to back their assertions, but this is a condemnation of the technique used by the introspectionists rather than of the problem. (Broadbent 1958, p108)."

The most fundamental, innate human ability is that of attending, or of selectively focusing our analyzing mechanisms on a limited area of relevant stimulation. Hernández - Péon, Scherrer, and Jouvet (1956b) described attention as involving "the selective awareness of certain sensory messages with the simultaneous suppression of others (p.331)." Similarly Reinhold (1955) suggested that "attention" describes "a state of heightened or increased awareness of particular sensations (p.417)." Certainly, the word attention has many and varied uses in psychological description. Generally however, two aspects stand out when a definition of the term is considered. Firstly, attention is related to intensity, or to those processes which determine the degree of an organism's alertness and vigilance. Secondly, attention is described as being selective - it determines which elements of the total stimulus field will exert a predominant influence over behaviour.

Studies of attentional functioning in normal Ss, and experiments in the selectivity of attention will be reviewed briefly. While this digression may seem unwarranted, it should be noted that there is a paucity of heuristric theoretical development in the attention studies of schizophrenia, as will be noted later. Consequently, the literature will be surveyed partly to place the study of attention with schizophrenics into some perspective in terms of research outside this particular field, and partly to establish and explore processes which will be used to describe schizophrenic cognitive deficit.

SELECTIVE LISTENING

Selective attention per se, was first largely investigated in the auditory mode, principally because hearing requires no peripheral localization, while comparable visual studies are confounded by fixation effects and the ease with which a visual signal can be shut out. The work of the 1950's culminated in Broadbent's (1958) attention model, based on his split-span experimental paradigm (Broadbent, 1954), and in three fundamental empirical findings (Broadbent, 1971): (a) The central processing mechanism appears to have a limited capacity. Evidence for this was provided by Broadbent (1952b, 1956a), Poulton (1953), Webster and Solomon (1955) and Webster and Thompson (1953, 1954).

(b) A physical cue, which permits differentiation between two messages, aids the selective process, e.g., Broadbent (1954b), Cherry (1953) and Poulton (1953, 1956).

(c) It is more efficient to indicate to Ss which channel is to be responded to before the messages arrive, rather than afterwards, e.g., Broadbent (1952a) and Cherry (1953).

Broadbent's model (1958) is of importance, because it was the first sophistocated attempt to deal with selectivity of auditory perception, and because it had considerable impact on thinking of clinical investigators (Yates, 1966a; McGhie, 1969). His model was based on a set of 12 postulates which organized the Central Nervous System into a communication channel of limited capacity, preceded by a selective device. This selector, using physical features of the stimuli monitors all inputs and selects information from sensory events with common features. There is also a bias in the choice of input, and certain events with novelty or high physical intensity may take precedence. The model contains a buffer storage unit which briefly retains information, but since this is of a limited capacity, a rehearsal circuit is included.

Modification of this model was forced by the results of a long series of studies by Anne Treisman and others (Lawson, 1966; Treisman, 1960, 1964a, 1964b, 1964c, 1964d, 1969, 1970, 1971; Treisman and Geffen, 1967; Treisman and Fearnley, 1971; Treisman and Riley, 1969) who showed that important information in the irrelevant message is at least partly analyzed at a verbal level. These experimental results were derived using the "shadowing" technique first developed by Cherry (1953), which requires the Ss to repeat verbatim, the primary message as it is being received. Treisman (1960), modified the original Broadbent model, by claiming that the filter did not totally prevent the verbal analysis of the secondary message, but merely attenuated irrelevant inputs. To the extent that only important stimuli receive full verbal analysis, these elaborations form the basis of the revised model advanced by Broadbent (1971, p148).

An alternative to the Attenuation model was provided by Deutsch and Deutsch (1963, 1967) and elaborated by Norman (1968). This conceptualization assumes that all input, irrelevant or relevant, is processed to the verbal recognition level. Processes posterior to the perceptual level, such as a short term memory buffer store, or a response selector mechanism, allow suppression of the input. The conflict between the perceptual attenuation theory, and the response suppression model are explored in more detail by Greenwald (1972).

Attempts to discriminate between the two models using the traditional shadowing task have not been successful (Norman, 1969; Greenwald, 1970b). However, a recent study by Greenwald (1972) indicates that both processes may take place in certain circumstances. He used an experimental task (Greenwald, 1970a, 1970b) in which conflict was produced by presenting auditory digit stimuli at the same time as visual digit stimuli, which served as the primary input. Efficiency of processing was measured by Reaction Time (RT) to the primary stimulus. The basis of Greenwald's (1972) experiment was to negate the conflict by means of habituation i.e., the conflicting auditory stimuli were repeated for several trials. Disruption of the habituation sequence was then initiated in an attempt to see whether secondary input suppression took place at a perceptual, or response level. Greenwald notes that this method requires a strong conflict situation and the necessity for some assumptions concerning the constituents of the response latency, and comes to the conclusion that:

> "The results for tests of perceptual filtering and response suppression indicated that both processes participated in the attention selectivity induced by the habituation procedure...This combination of processes is not necessarily paradoxical if it is assumed that the content of the distractor channel is fully verbally analyzed for the first few trials of each habituation series. Once this analysis has occurred, the nervous system (a) initiates a suppression of the response to be anticipated (continued) content of the distractor channel, and (b) reduced (or as Treisman (1964) has put it, attenuates) the level of perceptual analysis on the distractor channel. Such a multi-process selective attention mechanism could be quite efficient and functional (p. 65)."

The assumption that there is a single central processing channel is implicit in much of the work reported above, and in the studies of Moray, (1967, 1969), Welford (1968), Lindsay (1970), and others. Allport, Antonis and Reynolds (1971) have demonstrated that this is not necessarily true, and that Ss can shadow continuous speech while at the same time viewing pictorial scenes, or while sight reading piano music. Their multichannel hypothesis suggests that a number of independent and parallel processors operate on the input and that to the extent that any of the same processors are being used on differing input, will simultaneous performance of these tasks be possible. Hence, while the brain may exhibit single channel operation, there is no reason to accept that this is a generalizable phenomenon.

One final line of investigation (Underwood, 1972, 1973; Underwood and Moray, 1971) has postulated that the low detection rates of the secondary messages may be due in part to the allocation of "capacity" to the response required to demonstrate the degree of control of attention of the primary message. Response organization of the primary message requires so much energy that little is left over to handle competing inputs. The results of Underwood's (1972, 1973) studies indicated that response requirements do influence recall and detection of targets in the secondary channel. Further, it was found that serial position of a target strongly influenced probability of detection.

Thus perceptual factors and the physical similarity of two inputs may well interact with performance measures when sequential presentations are involved.

Research on selective listening is an ongoing area of endeavour, and the Norman and Treisman models of selective attention are undergoing the experimental scrutiny which they formerly accorded to the original Broadbent model. Many of the concepts developed in these studies have been applied to research of schizophrenic attention dysfunction, and many of the issues introduced in this context will be considered in more detail in subsequent chapters.

SELECTIVE VISUAL PERCEPTION

Selective visual attention has been studied using a multiplicity of tasks and the research has spawned a large variety of models, conclusions and experimental paradigms. Hence any review in this area must itself be selective, and the focus in this survey will be on the basic issues which have elicited the most interest, rather than on a definitive tabulation of all the empirical work conceived in this particular field.

Implicit in Townsend's (1971) work is a division of selective attention tasks into four major categories which will be examined in turn:

(a) Brief visual tachistoscopic presentations of complex stimuli, e.g. Estes' (1965) detection paradigm, (Rumelhart, 1970).

(b) Memory search experiments, using the paradigm established by Sternberg (1966, 1969).

(c) Binary forced choice, "same-different" reaction time tasks which have been used in a large variety of situations (Nickerson, 1969).

(d) The visual search experiments, which developed from the work of Neisser (1963, 1967).

This classification is not exhaustive, nor are the categories exclusive or independent. Because this thesis is derived largely from the latter two categories, the emphasis will be on those types of scanning task: however the other paradigms have produced data which is often of particular relevance to understanding scanning as a whole. It should also be noted that other researchers of schizophrenic cognitive deficit have adopted the first two experimental paradigms listed above. Several detection experiments based on Estes' work have been reported (e.g., Neale, 1971) and currently work is being carried out by Checkosky (Cavanaugh, 1973, personal communication) using memory search tasks.

Before proceeding to discuss the empirical evidence available, it is necessary to define the various variables, and the processes which are hypothesized to be important in the understanding of selective attention.

Models of Selective Visual Perception.

The fundamental ideas from which most scanning research has evolved, were explicated by Egeth (1966), and modified by Lehtio (1970), Grill (1971) and Hawkins (1969). They divided processing models into feature testing and template matching (Smith, 1968), and then, where appropriate, into serial or parallel processing modes, (Fig. 1-1).

The concept of parallel, or serial processing has been defined rigourously by Townsend (1971, 1972). The assumptions of a parallel model are:

(a) All elements are worked on at once, with processing commencing on all elements at the same time.

(b) Processing may finish at different times, if different elements have different processing rates.

(c) Processing may depend on the past, but not the future. That is, the processing of any element X_j of the set $X_1, X_2, \dots X_j, \dots X_n$ may depend on whether X_{j-1} or X_{j-2} is finished first, but may not be dependent on whether element X_{j+1} or X_{j+2} is finished last.

The basic assumptions of the serial model are:

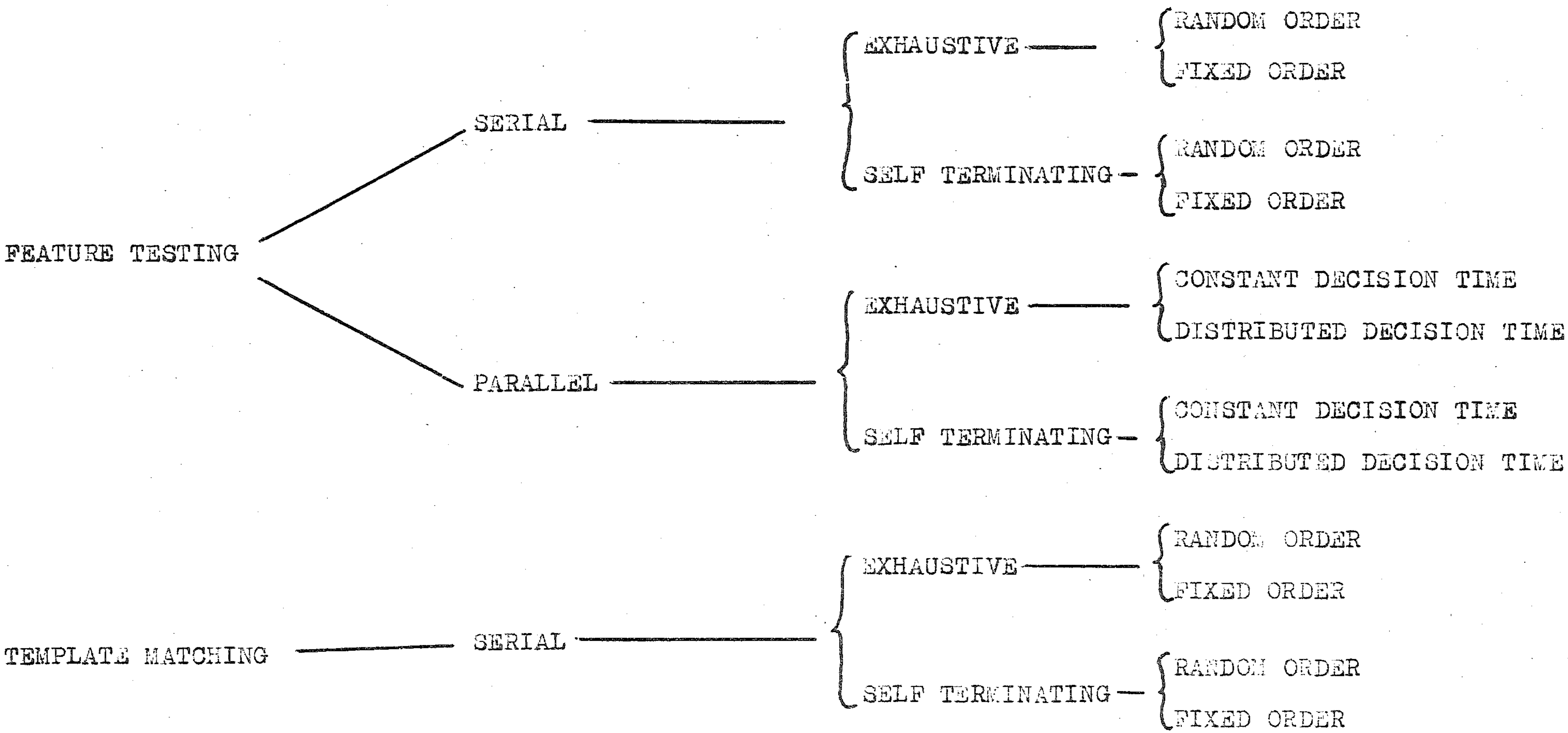
(a) Only one element is processed at a time.

(b) No one element is processed until the one preceding it has been completely processed.

(c) Different processing rates for different elements may hold.

(d) It is often assumed, for the sake of ease of mathematical manipulation, that the same order of processing is used on each trial for any one set of complex elements.

The theorizing of Egeth (1966), Hawkins (1970), Murdock (1971) and Ueno (1968) culminated in Townsend's comprehensive examination of the potential mathematical identifiability of parallel and serial



Potential Models of Visual Scanning. Based on Egeth (1966, 1967), and Hawkins (1970).

FIGURE 1 - 1

processes. Identifiability, a concept developed by Greeno and Steiner (1964), was adopted by Townsend to examine the possibility that the intangible processes lying between input and output may ever be determined to be either serial or parallel, as defined above. He has demonstrated, using expotential gamma distributions (McGill, 1963) to describe the processing times of elements, that the identification of parallel or serial systems is extremely difficult, especially when it is considered that a number of hybrid (mixed serial and parallel) systems may well hold, and mimic the strictly parallel or serial models. He showed, as have Murdock (1971), and Atkinson, Holmgren and Juola (1969), that when means of the distributions are examined, a strictly parallel system may predict the results which were commonly associated with a serial system; that is, a positive linear relationship between mean RT and the number of elements to be processed. So, while other controversies in this field - self terminating versus exhaustive search, limited or unlimited capacity - have proved tractable to some extent, the question of serial, parallel, or hybrid must remain unresolved in most of the contexts in which it has been studied.

The Study of Briefly Presented Stimuli:

The type of selective attention task involving recall of relevant information following brief tachistoscopic presentation has a long history (e.g., Boring, 1924; Brown 1960; Egeth, 1967; Harris and Haber, 1963; Kahneman, 1968; Lawrence and Coles, 1954).

Sperling (1960, 1963, 1967) proposed a model of information processing which implied the existence of a parallel operating receptor mechanism or iconic memory, out of which information was scanned in series.

Estes and others (Bjork and Estes, 1971; Estes, 1965; Estes and Taylor, 1964, 1966; Estes and Wessel, 1966; Grindley and Townsend 1970; Holding, 1971; Holmgren, 1968; McIntyre, Fox and Neale, 1970; Wolford, Wessel and Estes, 1968) have developed an experimental task in which they measure the probability of a correct detection of two letters amongst a number of random letters following very brief exposure. From this, Estes and Taylor (1964) derived a measure of perceptual span, corrected for guessing. The major reason for developing the technique was to provide estimates of the number of elements perceived from a brief visual display, with a minimal disruption due to memory loss. It was suggested that this technique was superior to the partial report technique of Sperling (1960) and Averbach and Coriell's (1961) "indicator" method.

The model which was developed using these tasks, was originally based on Broadbent's (1958) schema. All elements in the display are first registered in parallel and then the "traces" slowly decay expotentially. Before complete fading of the icon (Neisser, 1967), registered items are scanned serially, and then classified as either signal or noise. When the target element is encountered it is reported as detected, unless the trace has faded below threshold before detection occurs, in which case a random response is made (Estes and Taylor, 1966).

This general model, which is similar to those of Sperling (1967), Sternberg (1966), and Broadbent (1958) adequately explained early research results, but was unable to sustain the data of Wolford et al. (1968), and Bjork and Estes (1971). They used the RT procedure of Estes and Wessell (1966), and also varied the number of target or critical items in the display. If a serial model holds, then RT should decrease as the number of target items increases in a display with a constant number of elements. Wolford et al. (1968) found that when the raw data was corrected for changing proportions of guesses as a function of the number of redundant signals (using either an algebraic procedure or confidence level judgements), the curve relating RT to number of redundant critical items became horizontal. This supported the results of Atkinson et al. (1969) and was later confirmed by Bjork and Estes (1971). This led to a tentative revision of the model. Bjork and Estes concluded that the extraction of information from the elements, may be carried out in parallel (as in Wolford et al., 1968; Rumelhart, 1970). However, a serial self terminating model for processes invclving comparison of elements of a display, with items in memory, seemed to be indicated. Since in these experiments the redundant target element was always the same character, only one comparison would be needed with the memory element for a correct detection. This may lead then, to some resolution of these results with those from the memory scanning experiments (Wingfield and Bolt, 1970) and such same-different RT tasks as that of Bamber (1969).

Memory Search Experiments

The principal exponent of this particular paradigm is Sternberg, and since his first papers (Sternberg, 1966; 1967), a not inconsiderable body of literature has grown up using memory scanning experiments. The research methodology most commonly reported involves tachistoscopic presentation of a randomly chosen list of digits. Some seconds after exposure, the S is presented with one or more (e.g., Metlay, Handley and Kaplan, 1971) "probe" digits which may or may not have been presented in the stimulus sequence. The S is required to respond as rapidly as possible, indicating whether or not the "probe" was a member of the original stimulus sequence. Sternberg found a positive linear relationship, indicating a search time of 40 msec/item, between the RT and the number of items presented. Sternberg rejected the possibility of a parallel scan on two grounds - (a) if a parallel scan were self terminating there would be no relationship between RT and number of items in the stimulus sequence, and (b) if a parallel exhaustive search had been used, the relationship would have been nonlinear (Sternberg, 1966; Corcoran, 1970). This work led to a model of binary classification, with a series of additive stages (Fig. 1-2). This serial and exhaustive search model, which was investigated using the subtraction method proposed by Donders (1868), was developed by Sternberg (1969a, 1969b).

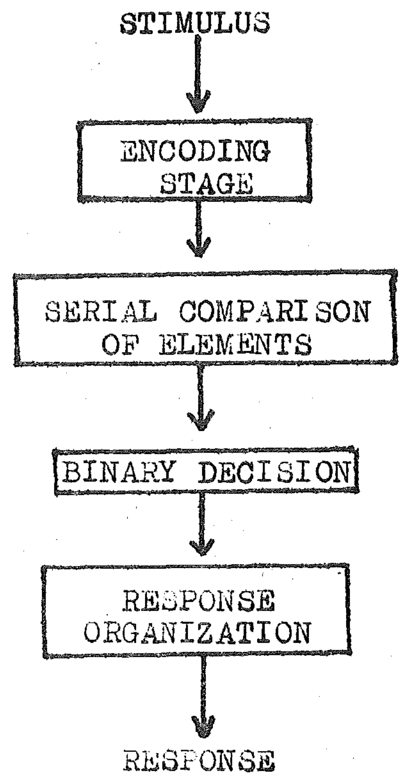


FIGURE 1-2

A four stage binary choice process in a memory scanning task (adapted from Sternberg, 1969; p.294). The first stage is influenced by stimulus quality the second by the size of the stimulus set, the third by the response type (present or not present) and the final stage by the relative frequency of the response type.

Nickerson (1966) extended the memory search paradigm when he compared and contrasted two tasks, (a) where a single item was in memory and several on display, and (b) several items in memory and one on display. The task was to decide whether any of the first set of letters (checklist) were included in the second set (search set), and to register the decision as quickly as possible. The results confirmed the importance of, (a) the number of items in the checklist, (b) the number of items in the search set, and (c) the number common to both. With relatively unpracticed Ss, RT was affected as much by differences in the checklist as by differences in memory set. Error rates tended to be high when a multielement checklist and a multielement search list had only a single element in common. Also, in contradiction to Sternberg, the number of pairwise checklist-searchlist comparisons did not appear to be exhaustive. The fact that for a specific number of items in each list, RT varied inversely with the number in common to the lists, suggested that as soon as a matching pair of items is found, search is terminated.

Various experiments since Sternberg's original publication have urged some caution in assuming this model to be entirely generalizable, especially with regards to the exhaustive search requirement. Corcoran (1970) reported an unpublished study in which serial position of the digit in the stimulus sequence affected speed of recall in an auditory version of Sternberg's experiment. A strong recency effect was found in the data of Clifton and Birenbaum (1970), provided the "probe" was presented less than a second after the end of the list. Burrows and Okada (1971) found not only strong serial position effects but also parallel slopes for positive and negative responses. They suggested that modifications to the original Sternberg serial exhaustive model may be necessary. It is possible to adopt the exhaustive search approach to strong serial position effects by assuming that such effects results from the entire scan being completed in less time if the target is in a favourable serial position. However, such results can also be explained in terms of, a parallel model (Murdock, 1971; Atkinson et al., 1969). Strong serial position effects were also found by Morin, DeRosa and Stultz (1967) and DeRosa and Baumgate (1971). They presented their positive set digits successively (in contrast to Sternberg's simultaneous presentation), and suggested that whether or not stimuli are temporally organized, through the interpolation of a pause within the digit series, strongly influences the serial position effects.

Wingfield and Branca (1970) reported two studies in which Ss searched memorized lists of up to 12 digits or letters for a probe digit. Reaction times were used to examine both strategies of recoding, and of search through memory. They found that Ss reduced memory load by searching for the test item among the complementary set when the size of the presented list was in excess of the size of its complement. While both experiments, supported the serial-exhaustive approach, Wingfield and Bolt (1970) suggest that fully exhaustive search may be limited to the case where it has been demonstrated most consistently : high speed scanning for a single target. Exhaustive search was not found when the Ss searched for more than one target, and where Ss are required to report the element following the target item in the positive set (De Rosa and Baumgate, 1971; Sternberg, 1967).

Several other results which require some incorporation into the Sternberg conceptualization have been published. Dumas, Gross and Checkosky (1972) have shown that the Sternberg model is disrupted by variations in the probability of stimulus elements or attributes. Connor (1972) inferred the existence of a serial memory set encoding stage, which would also explain Morin et al.'s (1967) results with temporally organized stimuli. Swanson, Johnson and Briggs (1972) used Posner and Keele's (1967) task which involved measuring same-different RTs to physically similar or dissimilar literal stimuli, and where it was found that Ss can respond "same" faster when two upper case A's are presented, than when A and lower case a are shown. Swanson et al. found a significant difference between a group who saw stimuli of the same physical format, and a group who were presented with stimuli which differed in physical dimensions, but had associational identity. They suggested that a recoding operation must take place before stimuli of differing physical format can be compared.

Practice effects have been reported (Briggs and Blaha, 1969; Burrows and Murdock, 1969) usually with alphanumeric stimuli. Dumas (1972) investigated memory search, with practice, using multidimensional geometric stimuli. The fact that RT was dependent on the number of shared attributes had been established by Nickerson (1967) and later replicated by Checkosky (1971). Consequently, Dumas used geometric shapes with a varied number of dimensions in common. His results were consistent with a model postulating self terminating comparisons within items, but exhaustive search between items in memory. He found also, in contrast to Neisser, Novick and Lazar (1963), that while the effects on RT due to size of the memory set disappeared, the effects of the dimensionality remained after eight days' practice - a result Dumas held to be inconsistent with parallel feature testing.

Klatzky and Atkinson (1970) looked at the case in which the test probe was not directly comparable to the stimulus sequence elements. Either letters, words, or pictures were used as probe elements while the memory set comprised letters only. Hence, the Ss might make a positive response if the probe stimulus was a word the first letter of which was a member of the memory set. Similarly, if the target stimulus was a picture, then Ss made a positive response only if the first letter of the name of that picture was a member of the memory set. Since this experiment showed that exhaustive search need not occur under some circumstances, Klatzky, Juola and Atkinson (1971) set out to define the conditions for such a search more rigourously. They required Ss to indicate whether or not a given target matched one of the previously matched memory set, where the target stimuli for a given session were either exclusively letters, exclusively pictures, or a random sequence of both. The RT functions of the letter or picture exclusive sessions were found to be consistent with an exhaustive model of memory scanning. The results for the random sessions deviated markedly from the predictions of such a model.

While Sternberg found a direct linear relationship, Nickerson (1966) found a logarathmic function, in a similar manner to Hick's (1952) relation. Briggs and Blaha (1969) suggested this may be artifactual, but more recently Simpson (1972) has found that mean RT was a function of $\log_2$ (positive set size). This in turn suggests some sort of binary choice comparison process consistent with the models of Hick, and Welford (1960).

Finally, Lively (1972) performed a study in which he used a memory set of either digits or consonants and a test set which could comprise either digits or consonants. Hence a negative response could be to either the same category probe, or the different category probe. He found that the slope of the RT function for the conceptually different negative items was less than for the negative items of the same class as the memory set.

Currently, the field of short term memory search is undergoing continual redefinition and development, and this expansion precludes the production of strong conclusions concerning theoretical and empirical data at hand. For example, there has been a trend, explored by Briggs and his students, towards the fitting of logarithmic relations to the RT versus positive set size function, and the introduction of the concept of uncertainty from the work of Attneave (1959) and others, on Information Theory (Briggs, Peters and Fisher 1972; Briggs and Swanson, 1970; Johnsen and Briggs, 1973 ; **Lyons and Briggs,** 1971 ; Swanson, Johnsen and Briggs, 1972). The serial nature of memory search has been generally accepted, although it has been demonstrated that the evidence presented, does not warrant the dismissal of the possibility of parallel search, (e.g., Murdock, 1971; Townsend, 1972; Townsend and Roos, 1973).

The exhaustive nature of the search has not been so clearly supported. While Sternberg (1969) found no serial position effects, these have been frequently reported in other studies (Clifton and Birenbaum, 1970; Corballis, 1967; Corcoran, 1970; Forrin and Morin, 1969; Kennedy and Hamilton, 1969; Kirsner and Craik, 1971; Morin et al., 1971). Forrin and Cunningham (1973) found that the existence of serial position effects may be a function of the time for which elements are retained before scanning and this accords with conclusions of Clifton and Birenbaum, 1970. Anders (1973), using retrospective report, as well as conventional RT measures has suggested that when search through large numbers of elements (up to 10) is required, Ss partition elements into subgroups which are searched exhaustively within subgroups, but in a self terminating manner, between groups. Theios, Smith, Haviland, Traupman and May (1973) have also pointed out that Sternberg confounded the probability of occurrence of a stimulus probe, and memory set size, and notes that probability has long been known to influence RT, (Hyman, 1953; Falmagne, 1965; Laming, 1968). They demonstrated that when this confounding was considered, self terminating models are at least equally as viable as exhaustive models, and somewhat more parsimonious.

At present then, there is a considerable disenchantment with the position Sternberg propounded in 1969, and this is reflected in the productive, but not yet conclusive search for alternative understanding of the dimensions of memory, and the resolution of conflicting experimental conclusions.

Same-Different Reaction Time Tasks.

Judgements of identity or nonidentity of geometric or literal stimuli have also contributed to the understanding of visual information processing. Such tasks can be structured so that Ss either see the stimuli to be compared sequentially (a basically memory task, similar to memory search), or else simultaneously, a perceptual discrimination task. While Sternberg's model is often invoked, data from this type of task do not point conclusively at serial search strategies, nor is comparison commonly made in an exhaustive manner (e.g., Snodgrass, 1971, 1972).

In general, in this type of study there has been a greater emphasis on a search for variables which influence RT in specific situations, rather than vigourous adherence to general models. Marcel (1970), for example, demonstrated that perceptual processing may well vary under different conditions. In an experiment using geometric data, he showed that while two conjunctions of values of four seperate dimensions may be analyzed in parallel, two conjunctions which are complementary, or from a same functional dimension, are analyzed sequentially. Checking whether a pattern is red and has a vertical bar, cannot be done at the same time as checking whether it is green and has a horizontal bar, (if these are the only alternatives on the relevant dimensions) even with fairly extensive practice. After some practice however, checking whether a pattern is red and has a vertical bar can proceed at the same time as checking whether it is a circle, and the bar is solid. One may attend, he suggests, to events simultaneously only when they are on functionally separate channels.

Keeley and Doherty (1968, 1969) obtained results of a similar nature. Subjects were required to report where a break in a Landolt ring occurred. They found that when the four C's with breaks in the same orientation were exposed successively, each at the same duration as when only one was exposed, there was a significant increase in the Ss' ability to identify the orientation (or hitrate) over the condition where a single ring was shown. However, when

four of the rings were exposed simultaneously for an equal duration, there was no increase in hitrate over the single exposure condition.
Marcel suggests, that this could be evidence for parallel receptors, and that testing whether the break is at "north" against all exposed Cs may be possible, but that it is not possible to test "south" in one ring at the same time as "north" in another.

Tasks more explicitly using a binary same-different choice have been reported (e.g., Bindra, Williams and Wise, 1965; Bindra, Donderi, and Nishisato, 1968; Nickerson, 1965). This led to the interesting demonstration of parallel processing and to the development of a new experimental task, some aspects of which will be reported in this thesis, (Donderi and Zelnicker, 1969; Donderi and Case, 1970).
Donderi and Zelnicker found that when up to 13 geometric shapes were exposed simultaneously to a S who decided whether all the shapes were the same or whether one of the shapes was different, response latency was independent of the number of shapes presented. They hypothesized that input from all the shapes were simultaneously processed into one, or two shape categories and that a decision theory choice was made between "same" (where there was only one category) and "different" (where there was more than one shape category), independently of the number of shapes.

This conclusion was extended by Donderi and Case, who exposed 2, 5, 8, 11 or 14 geometric shapes, and used three different conditions. These conditions were, (a) all shapes identical, (b) one shape different from the rest, and (c) with the 5-14 shapes stimuli, three shapes different. Decision latency was again found to be independent of the number of shapes presented, and correct "same" and " 3-different" decisions were faster than "1-different" decisions. Connor (1972) has shown that parallel processing in a similar situation holds even under conditions of increased irrelevant informational input. However, where the stimuli were made more confusing, that is when the distinctiveness of the different stimuli was reduced by using less clear type, or by using visually similar letters, processing became clearly serial. This suggests that the ability to attend to more than one stimulus input is limited by the necessity of using the same set of feature analyzers on the stimuli (e.g. Treisman, 1969; Marcel, 1970; Keeley and Doherty, 1968).

An experiment similar to that of Donderi and Zelnicker, was designed by Egeth, Jonides and Wall (1972) who also found, using up to six stimuli, nonrandomly placed, that RT was independent of the number of stimuli. These results can be related to experiments by Brand (1971) who discovered that looking for any digit in a background of letters, may proceed as quickly as looking for a specific digit in such a background. Hence categorization of overlearned stimuli, into functionally independent classes, may proceed in parallel.

Hawkins (1969) used a same-different RT task in which pairs of stimuli were varied along one or more dimensions - colour, size or shape, and each dimension had only two possible values. His findings supported none of the basic Egeth (1966) models. The results were however consistent with a model which postulated the following assumptions:

(a) Parallel processing of the different stimulus.

(b) Random distribution of decision time over trials.

(c) Termination of search when dissimilar dimension is found.

(d) Time required to interrogate one dimension covaries with time required to determine the state of the other dimensions.

The support for (a) was derived solely from the same response data which revealed that the RT for judging both of two dimensions the same was not slower than the RT for judging the single slowest dimension the same. Hence it is possible that a serial search mode may be employed when Ss are required to respond to differences in any dimension. Downing and Gossman (1970) performed a similar experiment which concentrated on the different responses. The results of their three studies strongly supported a parallel processing model. None of the data was clearly consistent with a serial process, but the results were also in agreement with Hawkins' four postulates, indicating that Ss can process multidimensional information with parallel but not necessarily independent channels.

Bamber (1969) reported a study in which a criterion set of letters was exposed to the S outside a tachistoscope and a test set which was briefly exposed tachistoscopically. Subjects were required to report whether or not all the letters in the second exposure were the same as the first. His data was not in accordance with the serial self terminating model he had previously suggested, and he developed a two process model to explain his results:

> "The two processes are a relatively slow difference analyzer, which works in series and a faster identity analyzer. The difference analyzer emits either a 'same' or 'different' signal, whereas the identity analyzer emits only a 'same' signal. A match between the 'same' of the identity analyzer and the 'same' of the different analyzer results in a fast 'same' response, whereas only the 'different' signal from a difference analyzer produces a 'different' response. When the test stimulus is 'same' both analyzers emit 'same' signals but since the identity analyzer is faster it has already initiated a 'same' response by the time the difference analyzer emits a 'same'. Therefore the 'same' response is faster than the 'different', and faster than would be expected by the serial self terminating model (p 213)".

Downing (1971) notes however that response probability bias may be important in determining these results. Egeth (1966), Nickerson (1965, 1967, 1969), and Bamber (1969) all found same judgements faster than difference judgements, whereas Downing and Gossman (1970) did not. Downing (1971) showed that this may be a result of the different probability of same and different responses. Williams (1972) felt that the Nickerson (1965) result might well be a function of the amount of specific practice with comparisons. He used Nickerson's sequential letter presentation task, and by controlling the number of times that particular stimulus pairs were presented in the same-different paradigm, controlled the effects of practice. He found that a same RT was faster, or slower than a different RT depending on the number of times a S responded to specific stimuli.

Grill (1971) has suggested a need for clarification of the conditions under which processes occur, that is, she has noted that results and models may well be highly task specific. She notes, for example that a wide variety of stimuli have been used; alphanumeric stimuli (Nickerson, 1966; Sternberg, 1966), randomly generated stimuli (Sekuler and Abrams, 1968; Snodgrass, 1971, 1972) regular geometric figures (e.g., Egeth, 1966; Hawkins, 1969; Lindsay and Lindsay 1966), or stimuli which vary along one integral dimension, (e.g., pitch or loudness; Nickerson, 1969). The comparison stimuli may be presented simultaneously (e.g., Donderi and Zelnicker, 1969; Egeth, 1966; Sekuler and Abrams, 1968) or sequentially (Atkinson et al., 1969; Bamber, 1969; Burrows and Murdock, 1969). Some Ss receive large periods of practice (Briggs and Blaha 1969; Neisser, Novick and Lazar, 1963; Sekuler and Abrams, 1968), others receive less (Donderi and Case 1971; Egeth, 1966). Grill manipulated three variables - (a) type of task (either simultaneous or sequential presentation of geometric stimuli), (b) relative set for speed as opposed to accuracy (e.g., Fitts, 1966), and (c) the effects of practice. The results indicated that responses were faster for successive rather than simultaneous presentations, and that while processing tended towards the parallel mode with practice in the simultaneous condition, this was not true in the successive condition. Relative speed and accuracy set, had little relation to response latency.

Same-different experiments have been carried out under a variety of conditions, and using a number of differing tasks. The evidence available suggests that extreme care is necessary in producing generalizable models. In contradistinction to memory search, there is little evidence of exhaustive search (e.g., Snodgrass, 1971, 1972). It is also clear that under some conditions, parallel search, illustrated unequivocally by a horizontal function relating number of elements to RT, may well occur. This appears to be true especially in tasks where simultaneous presentation, extensive practice and the possibility of interrogation of functionally independent dimensions is possible (Grill, 1971; Marcel, 1970; Neisser et al. 1963).

Visual Search

This considerable area of research endeavour was largely stimulated by the work of Neisser and his colleagues in the early 1960's, and much of the subsequent research in memory search and same-different RT experiments owes its initial motivation to these early papers. Visual search is defined here as the situation where the target element is presented before or simultaneously with the sequence to be searched. Memory search is the situation, as reviewed previously, where the target presentation is subsequent to the exposure of the stimulus or searched set of elements.

Neisser (1963) was directly concerned with the question of parallel and serial search strategies. He required Ss to search through letter lists for the presence or absence of one or more target letters, and perhaps the principle result of this work was the finding that searching for two target elements could proceed as swiftly as search for one target. While serial strategies could be devised to handle this data (Corcoran, 1970), no such equivocation is possible with the results of Neisser, Novick and Lazar, (1963). They found that with extensive practice, Ss could search for ten items as quickly as for one - clear evidence of unlimited capacity.

Kaplan and Carvellas (1965), and Kaplan, Carvellas and Metlay (1966) also demonstrated the dependence of scanning time on practice. When targets are searched for immediately after they are designated, search time is related to the number of target elements, and they postulated the initial condition of serial search is transformed, with practice, into a simultaneous search procedure. Kaplan et al. (1966) showed that this is true even when recognition times are separated from actual search times, using photographic records of hand and eye movements.

Shurtleff and Marsetta (1968) replicated part of the Kaplan et al. study, and failed to show a linear increase in scanning time as a function of the number of targets held in immediate memory. Shurtleff and Marsetta felt this disagreement may have been caused by the fact that the Kaplan et al. experiment actually increased the number of targets to be responded to in each stimulus presentation as the number of targets increased, whereas in the later experiment the number of targets to be found did not increase with the number of targets in immediate memory. This would not however reconcile Shurtleff and Marsetta's results with those of Kaplan and Carvellas (1965). However one further difference, which may explain the discrepancy, is that the Kaplan experiments used targets drawn at random from all 26 letters of the alphabet, whereas Shurtleff and Marsetta selected their targets from a specific set of six elements.

An experiment by Metlay, Sokoloff and Kaplan (1970) tends to support this conclusion. They found that when a S searched a list of letters for one to five different targets which were randomly chosen from all 26 letters of the alphabet, the time required to scan the lists increased as a linear function of the number of targets searched for. When the targets were chosen from a specific set of five letters however, while scanning time increased with the number of targets stored in memory, the increase was smaller, and negatively accelerated. Metlay et al. concludes that this implies that the number of "feature tests" required increases with the number of potential targets, although with sufficient practice, when searching for a specific letter set of targets the Ss ultimately became able to test for them simultaneously. It is also possible that the curvilinear increase when the S memorized a small subset of the potential targets, may represent an intermediate stage in the gradual transition from serial to parallel.

The serial processing approach was strengthened by Nickerson and Feehrer (1964), who found a monotonic increase in RT with the increase in the number of target elements, in an experiment where stimulus letters were presented sequentially in a tachistoscope and where Ss were required to respond only to the critical items. This result was confirmed by Chase and Posner (1965). Rabbitt (1964, 1967) showed that not only the number of targets, but also the number of non critical elements, increased response latencies. Subjects appeared to search not only for features which distinguished a target element, but also those identifying a noncritical element. Whether target or nontarget elements are tested for, may well be a function of the probability of target occurrence. In the Neisser paradigm, probability that any letter is a target is approximately 0.02, whereas in Rabbitt's experiment, this probability tended towards 0.5.

One of the few experiments on novelty and scanning was conducted by Neisser and Lazar (1964) who showed that Ss can search for any unfamiliar element in a list of letters as rapidly as for "any digit", but less rapidly than for a fixed and familiar element. This suggests novelty is not an immediately given property of stimulus elements, but the product of one particular pattern of processing

Neisser and Beller (1965) reported two experiments in which Ss searched through word lists for targets defined in terms of their meaning (e.g., "any animal"). Scanning time was found to be greater in this situation, than when the target is a specific word, or a member of a defined group of words. Similarly, Neisser and Stoper (1965) required Ss to scan word lists and to report proper names. Some of the lists contained "cue" words which made it possible to skip a number of lines. Several seconds were necessary to make such a skip, thus cues for short skips were not used. The researcher surmised that the skip response might not be under direct stimulus control, implying that eye movements might have a pattern controlled by higher order mechanisms.

The original Neisser results have been confirmed and extended in a number of ways (e.g., Peterson and Peterson, 1970). Brown, and his colleagues at the University of Exeter have also tackled some of the problems raised by Neisser (1963). Strongman and Brown (1966) instructed Ss to search for a meaningful word in a nonsense word context, or a nonsense word in a meaningful context. Within each of these conditions two levels of word frequency, and two levels of nonsense syllable association value were presented. Hypothesizing from Neisser's results, it was expected that search for an item not possessing an attribute (negative instructions) would lead to longer RTs than would search for an element possessing a specific characteristic (positive instructions). The results showed that visual search times were significantly influenced by both the frequency of the target words, and the association value of the context items. There was also a significant interaction observed between type of instructions and target frequency. Brown and Chick (1970) clearly confirmed Neisser's (1963) finding that searching for the row that does not contain the target element, takes longer than searching for the one row which does contain the target. One experimental difference which may account for this is that the definition of a target in the two cases is completely different. In searching for a target's presence, the notion of a row is not necessary, however in order to report the absence of a target, the letter structure of the row is important.

The influence of the context in which the target is buried has been further studied by Portnoy, Portnoy and Salzinger (1964). They instructed Ss to locate nonsense target syllables in fields of other nonsense syllables. They varied the relative association value of the target and the field. The results indicated that search time is lower when the target association value is high, and when there is a difference between target and field. Similarly, Schultz and Lovelace (1964) found that Ss located high meaningfulness CVC trigrams more rapidly than those with low meaningfulness.

Smith and Egeth (1966) criticized Portnoy et al. (1964) on the grounds that their measure of search time did not permit a computation of decision time per item, from the total number of items searched. Hence no conclusion as to whether familiarity effects decision time per item examined, or the total number of items actually examined. They therefore used a Neisser format to reduce the potential strategies. They did not find that familiarity influenced discrimnability using the decision time per item criterion. Hence the effects of familiarity may be confined to unstructured search situations.

Krueger (1970a) employed an interesting design which required the S to search for a target letter amongst visual displays of varying redundancy. He showed that Ss can find a target more quickly in structured stimuli (words or pseudowords) than in non structured groups of letters. Also, Ss search more rapidly through coherent sentences than through scrambled lists of words. He showed, by increasing the number of memory comparisons (Ss searched for more targets), that redundancy aids search by speeding the initial encoding stage. Even when familiarity is induced within one experimental session by repeating sequences, (Krueger, 1970b), Ss search more rapidly through the repeated displays, than the nonrepeated sequences. Letters are also recognized more accurately when they appear in words rather than nonwords, (Reicher, 1969). Krueger (1970c) reported a further experiment in which Ss were shown a target letter centred above a six letter nonword (but only when the sequence was arrayed horizontally, and not when it was shown vertically). Memory search was also demonstrated to be more efficient through words than through nonwords (Krueger 1970c; 1971). These results are augmented by those of James and Smith (1970) who found that vowel probe letters were faster than consonant probes for words, but not nonword sequences. This result is probably a function of the S's knowledge of English and the sequential dependencies in the language which indicate likely environments.

Gordon (1968) has identified a source of difficulty in visual search which is related to the variety of irrelevant items (Rabbitt, 1964, 1967, has also noted this). He found it takes longer to find and cancel lower case 'a's, when these are hidden amongst 'e's, than when they are hidden amongst equal numbers of 'b's; but when the 'a's are hidden among equal numbers of 'b's and 'e's, search is slower than in either single irrelevant item condition. Further increases in RT follow when the number of nontargets is raised to four (or from 3 to 24; Gordon, Dulewicz and Winwood, 1971). This variety effect also occurs with abstract patterns (Gordon, 1968). Gordon (1970) recorded eye movements during a similar task (search through thousand line lists of 25 letters per item) and found that the main response to a change in degree of complexity of the search lists was an increase in the number of fixations, pauses, and visual regressions.

Colour coding has also been shown to reduce search times (e.g., Green and Anderson, 1956; Smith, 1962; Mendell and Whiston, 1970; Smith, Farquhar and Thomas, 1965). Kinsbourne and Innis (1972) have demonstrated also that visual search may be self terminating. Subjects searching through stimulus sequences for a target element, which, when present, was half the time represented once and half the time twice, in any array. They found that increasing the number of targets significantly reduced RT.

Cohen (1968, 1970) who was concerned with specific abilities in reading, has also devised some interesting visual search tasks. The study compared search for letter shapes, for accoustic targets (specific phonemes), and for semantic targets (words of a specific meaning class). It was found that search times were least for semantic targets, and greater for accoustic targets than for visual letter targets. Comparisons of the search times also revealed that the addition of a semantic target to accoustic or letter targets did not increase search time, so that these may be processed in parallel. Other combinations of processing types yielded search times that are slightly faster than a serial model would predict and could at least be interpreted as implying an overlapping sequence of operations.

Snyder (1972), with reference to models of visual search, notes the common two process theory which involves localization of the visual target and the analysis subsequently of its features. This has some relation also to animal and physiological experimentation. Snyder used a detection paradigm, in which Ss were required to report the one inverted letter and its spatial position. He found that elements adjacent to targets were reported more frequently than other non targets. This data supported the two stage model. The location and identification stages also appear to correspond to the "preattentive" and "focal attentive" stages in Neisser's (1967) model. Operating on easily recognizable features of the stimuli, the preliminary preattentive stage can, with adequate practice, detect multiple targets, in parallel. The subsequent focal stage operates more slowly and in a serial fashion on the less discrimnable stimulus features. In the Neisser task, where only targets require a response the preliminary stage rejects non targets, but allows targets to pass through and be identified. Reports from the Ss, for example, suggest that they hardly "see" the irrelevant elements (e.g., Neisser, 1963). Cavanaugh and Chase (1971) attempted to compare this type of theory with Sternberg's (1966) results, in a situation where the response characteristics of the two types of task (item recognition and visual search) were held constant. The results favoured a Sternberg serial search process. However it should be noted that stimulus sequences of only up to six letters were used, hence the ratio of targets to nontargets was very high. In Neisser's original task the ratio was considerably lower, and it may well be that a preattentive model is meaningful only where a high proportion of nontargets compared to targets, is to be found.

Finally, in the comparison and contrast of Sternberg and Neisser's hypotheses, their conflicting results concerning the effects of practice have been explored (Kristofferson, 1972a, 1972b, 1972c). She has found that when nested target sets are used (that is, each target set contains all the items in the smaller target sets), and response consistency, (i.e., an item in a Sternberg task is used for either negative or positive trials, but not both) is observed, the effects of prolonged practice upon set size in memory search and visual search does not differ.

Teichner and Krebs (1974) reviewed a number of experiments based on the simple target search paradigm. They proposed that the evidence suggested a sequential scanning process with a maximum capacity of about 50 elements per second. This basic model - a serial system which may act as a parallel system in subcapacity conditions - is implicit in the models of visual search discussed in later chapters of this thesis. In contrast also to Atkinson et al., (1969), Egeth et al. (1972) and Townsend (1971), Teichner and Krebs argue that overall processing rate per item decreases as number of stimulus elements increases, up to a limiting value. More consideration of this conclusion will be undertaken in Chapters 3, and 4.

CONCLUSIONS:

Erdelyi (1974), in a retrospective examination of selectivity of attention research, notes that since the later 1950's (perhaps Broadbent's 1958 text can be used to signpost the turningpoint) the emphasis in attention theorizing has swung away from the formulations espoused by the New Look psychologists (McGinnies, 1949; Postman, Bruner and McGinnies, 1949), and towards the conception of man as an information processor. This conceptualization has tended to encourage construction of complex multiprocess structural models of selective attention (e.g., Neisser, 1967; Moray, 1970; Norman, 1968; Treisman, 1969). Many of the old notions of cognitive style, expectancy - set, and perceptual vigilance have gradually been replace by more heuristic and rigourous approaches. In the clinical study of cognitive deficit however, as will be evident in the subsequent chapter, many of these ideas linger on. The dependence of such defect theories on outmoded ideas of information handling has often tended to undermine the validity of such theoretical structures.

This does not necessarily suggest however that discourse on attentional, focal processing has been without controversy. The original Broadbent Filter Theory, which introduced many of the structural systems still utilized by cognitive deficit researchers (especially the idea of a filter), was challenged and superceded by the competing Filter Attenuation Theory (Treisman 1960, 1964d, 1969) and the Response Suppression

Theory (Deutsch and Deutsch, 1963, 1967; Norman, 1968). Treisman's theory implied that the bottleneck or filtering stage in processing structure occurred at the perceptual level. She proposed also that parallel processing is possible for two concurrent inputs only in the situation where both inputs do not require the same feature analyzers. Norman (1968) however pushed the bottleneck further back in the processing system claiming that the suppression or non suppression of a potential response determined the ultimate output. To date no unequivocal resolution of the differences between these theories has been achieved (e.g., Kahneman, 1973; Moray and O'Brien, 1967; Norman, 1968).

The extent to which most models are task specific is recognized by many authors. As Kahneman (1973) notes many studies are concerned with auditory selective attention and that the conclusions of these studies do not generalize readily to visual experimentation. Kahneman is tempted to speculate that:

> "...the modern study of attention could have taken a different course if Broadbent (1958) had been concerned with how one sees dancers rather than with how one hears messages. Since it is surely possible to see many dancers while attending to one, the concepts of a filter that allows inputs into perception in single file might not have been proposed. Deutsch and Deutsch (1963), on the other hand, might not have argued that attention does not alter perceptual analysis, because the difference between the perception of a prima ballerine and of lesser dancers is too obvious to be ignored. Finally,

> the traditional emphasis on spatial organization in vision would have led much sooner to a discussion of the pre-attentive mechanisms that control attention. (p.135)."

One final approach to selective attention might be introduced at this stage. Merging ideas from Treisman, and Norman with those of Hochberg (1970), Freud (1900) and Rapaport (1967), Kahneman 1973 has developed a capacity theory of attention. His work rests on the proposition that:

> "Selective attention to inputs is the allocation of capacity to the processing of certain perceptual units in preference to others....The distinctive predictions of the present theory are that the effectiveness of selection depends on the ease with which relevant stimuli can be segregated at the stage of unit formation, and that the effectiveness of rejection of irrelevant stimuli depends on the amount of capacity demanded by the primary task. (p.135)."

To some extent this is a comment also on the parallel - serial controversy; probably both may occur, depending on the processing requirements of the task. However, this notion will be discussed further later.

CHAPTER TWO

THEORIES OF COGNITIVE DEFICIT IN SCHIZOPHRENIA AND PROBLEMS OF RESEARCH AND INTERPRETATION OF RESEARCH IN THIS AREA.

> "As the disease needs not progress as far as dementia and does not always appear praecociter, i.e. during puberty or soon after, I prefer the name schizophrenia.
> This disease may come to a standstill at every stage, and many of its symptoms may clear up very much, or altogether; but if it progresses, it leads to a dementia of a definite character (Bleuler, 1924; p. 373)."

Introduction

This chapter is divided into two sections, the first a discussion of research, grouped about the major theoretical endeavours published in this field, and the second, an attempt to evaluate some of the problems which confront the researcher in constructing and interpreting experimental studies of the cognitive deficit of schizophrenics.

Since the literature is extensive, this review can attempt only to present a selective view of the research, and to centre around the studies of information, processing aspects of attention deficit. Several large scale literature reviews (e.g., Buss and Lang, 1965; Lang and Buss, 1965; McGhie 1969; Shakow, 1972a; Yates, 1966a, 1973; Zimet and Fisherman, 1970) exist which expand and supplement the literature to be presented here.

Although the literature discussed below will be presented as relating especially to one particular theoretical orientation or another, this does not imply that the different theories are in fact incompatible. Rather than a series of contrasting theories (with the term "theory" being used in a rather wide ranging sense) this particular field seems to have spawned a number of theorists who are saying much the same thing, but in a number of different ways. The way in which the theoretical orientations resemble one another becomes apparent as the different lines of research are pursued, and one focus of this survey will be on the way in which theories of cognitive dysfunctions are similar, one to the other, and the ways in which they may be formally identified in the sense that identification is used by, for example, Greeno and Steiner (1964), and Townsend, (1972).

PART 1 COGNITIVE DEFICIT RESEARCH WITH SCHIZOPHRENICS:

Shakow's Set Theory

Historically one of the most significant, and longest ongoing endeavour in the field of schizophrenic cognitive deficit, has been the study of 'set' by Shakow and his colleagues at Worcester (Shakow, 1963, 1972a, 1972b). From his RT studies, Shakow has concluded that;

> "This immense variety of schizophrenic symptoms can in one sense be viewed as different expressions of only partial integration, or individuation, or breakdown of major sets - in other words, of segmentalization (Shakow, 1963; p.303)."

Huston, Rodnick, Rosenthal, Zahn and Shakow have been the major researchers using RT studies in this context. Their earliest studies showed that the schizophrenic deficit did not lie at the simple level of the patellar reflex (Huston, 1935), nor at the sensory level (Huston, 1934). It soon became clear however that schizophrenic performance deteriorated as the demand quality of the experiment increased (Huston, Shakow and Riggs, 1937), and that with self paced tasks, such as tapping (Shakow and Huston, 1936) and steadiness (Huston and Shakow, 1946) it all but disappeared. They found also that schizophrenics show an initial difficulty in adapting to the experimental situation but improve with practice (Huston and Shakow, 1948, 1949).

Huston, Shakow and Riggs (1937), provided one of the earliest studies in which RT was systematically examined in a psychotic group with a large enough number of Ss to permit generalization. They used simple auditory and visual RT, and disjunctive visual RT tasks and found that the patients had higher mean RT values, and greater within group and within subject variability. In a second set of experiments, reported in this study, preparatory intervals (PI) were varied by increasing or decreasing the foreperiods prior to stimulus exposure. The results from this study were taken to show that schizophrenics, in addition to not attaining as high a level of readiness before stimulus onset as normals, are also unable to maintain a level of preparation consistently. These results were extended (Rodnick and Shakow, 1940) and formed the basis for the continuing study of set and schizophrenic deficit.

Rosenthal, Lawlor, Zahn and Shakow (1960) endeavoured to determine the way in which mental set is related to degree of schizophrenic disorganization. Using Rodnick and Shakow's Set Index they performed an experiment which varied PI, and found that the Index was highly correlated ($r = 0.89$) with degree of ego intactness, as rated by nine qualified judges. Hence set, or degree of preparedness for a stimulus, is an important parameter in measuring the degree of cognitive disorganization of schizophrenics.

Zahn, Rosenthal and Shakow (1961), followed this study with one designed to study the effects of varying the PI in a regular manner. In half the sessions, the PIs were in ascending order (1, 2, 4, ... seconds), in the other half they were in descending order. They found that in the ascending condition, RT was an increasing function of PI length for both groups, although the schizophrenics' gradient was greater. In the descending condition, RTs of the patients did not vary with PI, and were relatively slow. The normals showed no difference in either ascending or descending conditions. These results were interpreted as implying the inability of the patients to extinguish an inadequate set or response pattern previously imposed by suboptimal external conditions, when this set became inappropriate.

Zahn et al. (1963) extended this result by showing that the best performances by schizophrenics occur with about one second PI, and that the schizophrenics' results were disproportionately influenced by increases in PI, as compared to normals. In addition, slowness on shorter PI values is due largely to the preceding PI. Instead of focusing their preparedness on their total experience of the PI's, the schizophrenics base it on the most recent event in the series. This finding is reinforced by the results of a study by Sutton, Hakarem, Zubin and Portnoy (1961), who used a simple RT task whereby a schizophrenic or normal S removed their finger from a key in response to either a light or an auditory stimulus. They found that schizophrenics consistently react more slowly to a stimulus which is preceded by one in the other sensory modality, than to a stimulus preceded by one in the same sensory modality.

Studies by Cromwell, Rosenthal, Shakow, and Zahn (1961), Knehr (1954), Zahn, Shakow and Rosenthal (1961) and, Zahn and Rosenthal (1965) have essentially confirmed previous conclusions. Confirmation has also come from studies which do not focus on PI, e.g., Tizard and Venables (1956), and Wienckowski (1959). The maintenance of the set is also measured by Kornetsky and his colleagues (e.g., Orzack and Kornetsky, 1966) with the Continuous Performance Test, and the general finding is that schizophrenics' performance in a vigilance situation is poorer than that of either alcoholics or normals. It was also found (Shakow and McCormick, 1965) that when some discrimination is required and "noise" stimuli are interpolated amongst the "target" stimuli, the schizophrenics' RTs are markedly lengthened. Although there has been little study of differences between the subgroups of the schizophrenic population, Shakow (1972b) speculates that the paranoid organizes his environment, so as to keep it under rigid control (Angyal, 1942; Shakow and Rosenweig, 1937). The hebephrenic however appears to be at the mercy of his environment and his more massive thought disorder results from the constant intrusion of irrelevant stimulation.

The set theory explanation of Shakow derives it's stature as a summary of a long series of results, rather than as a predictive model. As a predictive formulation indeed, it seems somewhat facile. One can legitimately ask why there are problems of set in schizophrenics, or why minor sets should intrude upon major sets. Similar research, using geriatric Ss, may provide some meaningful answers (e.g., Rabbitt, 1962, 1965a, 1965b; Talland, 1965; Botwinick, Brinley and Birren, 1957). Rabbitt (1968) notes that when stimuli are presented in an irregular fashion (i.e., with varied foreperiods), in order for Ss to operate at an optimal level a great deal of information from previous trials has to be encoded, stored and built into subjectively structured probablity distributions.

With irregular foreperiods, Ss speed of response depends on efficiency of both the analysis of new input and its relation to stored input, and the capacity of short and immediate term memory stores. If schizophrenic and geriatric Ss have a reduced information encoding, processing and storing capacity, they may make use of redundant information, or they may so structure the situation that only a limited quantity of relevant information is available, and thus a suboptimal response rate or latency is achieved. Hence, it may be argued that while the experimental work of Shakow is of importance, the value of his attempt to integrate his data, because of its lack of rigour in the context of formal cognitive psychology, and because it can not be directly used to construct a heuristic theoretical framework, is of less significance.

Distraction and Cognitive Deficit

Research into the effects of auditory and visual distraction on schizophrenic performance has been carried out in a number of studies by McGhie and his colleagues (e.g., Chapman and McGhie, 1962; McGhie, 1966, 1969; McGhie and Chapman, 1961). McGhie, Chapman and Lawson (1965a, 1965b) used a variety of tasks to investigate the effects of distracting inputs on the processing of information. In their first study, McGhie et al. (1965a), they found that both visual and auditory distraction differentially affected schizophrenics compared to controls, when

Ss were asked to recall digit or letter sequences. Since it is not reported whether the distraction trials were given before or after the nondistraction trials, or whether a random sequence was used, the effects of practice or of the irregularity can not be assessed. In the second study, McGhie et al. (1965b) found with several psychomotor tasks, schizophrenic patients performed more poorly than nonschizophrenic controls. The tasks which showed particularly detrimental effects due to distraction were those with the greatest amount of processing, and with the most unpredictability of response.

Lawson, McGhie and Chapman (1967) extended this work with an experiment using the same digit recall technique used in the McGhie et al. (1965a) paper. They found that the distraction effect was primarily to be found in the auditory modality and was confined largely to hebephrenic Ss. As the authors acknowledge, no attempt was made to equate for discriminability between modalities. The difference between modalities was not found by Venables (Venables and O'Connor, 1959; Venables, 1960, 1963), however as McGhie (1967) points out, this may be due to the use of different tasks, and of patients of different clinical status.

The McGhie findings concerning distraction have generally been confirmed by other investigators (e.g., Tizard and Venables, 1957; Payne and Caird, 1967) and have led to a theoretical interpretation of the data by McGhie and others in terms of Broadbent's (1958) model of selective attention. McGhie (1969) hypothesizes that in schizophrenia the normal filtering processes have collapsed, and hence these patients are unable to separate relevant information from "noise", resulting in a consequent suboptimal performance. This is particularly true of tasks involving complex or unpredictable stimuli. This need not be the entire explanation, as McGhie himself notes, since schizophrenics perform poorly even in the absence of any distraction.

The difficulty with accepting McGhie's formulation lies in the simplistic way an apparently complex and situational deficit is explained as being the product of distraction. How does a distracting input account for performance decrement? McGhie's explanation of the distracting effect is hampered by its conjunction with the original Broadbent model of attention, which even its author (Broadbent, 1971) acknowledges as deficient. Several other explanations may well be worthy of consideration.

(a) Schizophrenics may not attenuate distracting information at an early enough stage in the processing sequence. This acknowledges that even distracting input must be examined at some stage in order for its irrelevance to be established.

(b) The stimulus "filtering" process, involving encoding, storing and testing relevant or irrelevant information may be inefficient, of limited capacity, or particularly slow.

(c) Due to a more limited processing capacity, schizophrenics can sample fewer inputs both relevant or irrelevant, thus information overload would increase with distraction conditions and lead to a consequent performance decrement. If all information is processed slowly then the distinction between distraction and nondistracting stimuli is of less importance than the speed of input handling - this explanation is akin to that of Yates (1966b).

(d) Response mechanisms may be important. If the information in sequential presentation of elements is stored inefficiently, or if it takes longer for the schizophrenics to make a response, which would allow greater decay of stored input, then this factor may interact with distracting stimuli in some way.

In the context of the theoretical climate of cognitive psychology of the later 1950's, McGhie and Chapman's work is of considerable interest. It lacks however an appreciation of potentially complex interaction of distraction with relevant informational input, which can only be resolved by the detailed and systematic examination of the nature of the effects of irrelevant stimulus input.

Arousal Level and Schizophrenic Dysfunction.

Since the focus of this thesis is not the psychophysiological aspects of cognitive dysfunction this area will not be extensively reviewed. The literature has been broadly covered by a number of writers, especially Claridge (1967), Teece and Cole (1970), McGhie (1966, 1969), Spohn, Thetford and Cranco (1971), and Venables (1964, 1966). In general, arousal theories have a strong physiological basis, and run parallel to the more specifically psychological theories of Yates, McGhie and others. It is clear that if schizophrenics have difficulty maintaining sets etc., then this disability must be mediated at a neurological level, and the undertaking of Venables, Claridge and other researchers has been to define the deficit at that level.

Venables (1964, 1967) has attempted to systematize research findings into one generalized statement:

> "Chronic schizophrenic patients - and possibly included in this category are process patients - tend to be characterized by a state of restriction of the attentional field resulting from elevated states of sympathetic and cortical activation. Attention is restricted not only to the extent that peripheral sensory items contemporaneously present do not rise into consciousness, but also involved is the nonrecognition of items in memory which form part of the meaningful structure in which the present central item appears....
> In contrast to the chronic patients, the acute (and possibly the reactive and paranoid) patient is characterized by an inability to restrict the range of his attention so that he is flooded by sensory impressions from all quarters. Items of all kinds have equal importance, and the meaningfulness of the external world tends to be lost for the opposite reason to that which applies with the chronic patient (Venables, 1964; p.41)".

Claridge (1967) has evolved a more complex theory which is intuitively attractive, but which is based on the somewhat unproven association between spiral after effect results and cortical arousal. His formulation involves a two stage model, one stage of which is a tonic arousal system which maintains a constant level of arousal and the other stage an arousal modulating mechanism which can alter the arousal level of the first stage, and which serves to filter irrelevant information out of the system. In schizophrenia the two stages become dissociated, due to a failure of the feedback mechanisms. This may result in a failure of the modulating system, which would then no longer inhibit the tonic system and would thus result in a high continual arousal level. However if the tonic system were weakened the controlling modulating system strengthened, then overall arousal would be very much constricted.

Neither theory can be said to have been firmly established nor to have been conclusively contradicted (Neale and Cromwell, 1970; Frith, 1973; McGhie, 1969). In general, the relation between arousal and attention has yet to be clearly established in relation to schizophrenia, although the relationship seems to be eminently reasonable. The relationship between chronic and acute schizophrenia, which is a strong prediction from Venables' (1964) theory, has not been unequivocally established (Buss, 1966; Teece and Cole, 1972; Lang and Buss, 1965; Maher, 1966).

Silverman's Cognitive Control Theory

One of the most pervasive attempts to integrate deficit research has been undertaken by Silverman (1964a, 1968, 1972). The origins of his formulation of cognitive control principles lie, as Neale and Cromwell (1970) have described, in the work of Gardner, Holzman, Klein, Linton, and Spence (1959), Gardner and Long (1962a, 1962b), Klein (1954), Piaget (1950) and Witkin, Lewis, Hertzman, Machover, Meisner and Wapner (1954).

Attention as explicated by Silverman (1972) involves three major factors:

(a) Stimulus Intensity Control, that is, the ability to respond to very high or very low intensity stimulation. This has led to the distinction between augmenters (those who typically amplify sensory stimulation) and reducers (who attenuate sensory stimulation), based on the work of Petrie (1967).

(b) Scanning Control. This was a fundamental factor advanced by Silverman (1964a) to account for differences between psychotics and normals. Acute and good premorbid patients, as well as paranoids, were hypothesized to be "extensive" scanners, while acute poor premorbids and predominantly nonparanoids, were hypothesized to be minimal scanners. During chronic phases of the disability, these scanning control responses are assumed to reverse.

(c) Field Articulation Control. This followed from the work of Witkin et al. (1954), and Witkin Dyk, Paterson, Goodenough and Karp (1962) with the rod and frame, and embedded figures tests. From this was inferred the notion of field-dependent Ss who take, for example, a long time to find embedded figures because they are distracted by the contextual field; and field-independent Ss who are not readily distracted.

To examine in detail the evidence relating to this theory is beyond the scope of this review, particularly as much of the literature has been covered by Silverman (1964a, 1972), Neale and Cromwell (1970), Frith (1973), and Cromwell (1972). A few general points however can be made.

(a) Silverman's concept of cognitive controls is dependent on the interpretation which can be placed on the tasks he uses to measure such controls. Neale and Cromwell note that with field articulation tasks, performance correlates highly with results on other spatial tests which do not involve contextual distraction (e.g., the Primary Mental Abilities Test; Sherman, 1967).

(b) The tasks most commonly employed by Silverman and his colleagues to substaniate his scanning control behaviour hypothesis, have been size constancy (e.g., Clark 1966; Crooks 1957; Hamilton 1963, 1972; Price and Eriksen 1966; Weckowicz 1957; Weckowicz and Blewett 1959) size estimation (e.g., Davis, Cromwell and Held 1967; Harris 1957; Neale and Cromwell 1968; Neale, Davis and Cromwell 1967; Silverman 1964b; Zahn 1959) and kinesthetic figural aftereffects (e.g., Silverman, Buchsbaum and Henkin, 1969). Results are clearly conflicting (Neale and Cromwell 1970) but there appears to be limited support for the formulation especially with the size estimation data. Cromwell (1972), and Neale and Cromwell (1970) have noted however that the evidence is very fragile. While the overall theory of cognitive controls is attractive, the tasks used to hold the conception together may have a tenuous relation with the basic theory. With size constancy some of the conflicting results may well be resolved by a closer examination of the instructional set and the Ss understanding of the task. Size estimation performance deficit appears also to be very dependent on momentary states. Usually such an experiment is based on a small number of trials (Harris 1957; Silverman, 1964b) and when a larger number are given the results tend to dissipate.

(c) Silverman (1972) has pointed out that his theory is compatible in essence with the results of other studies (e.g., Broen, 1966; McGhie, 1966; Neale et al. 1967; Payne and Caird, 1967; Yates, 1966a). This again presents a problem of identifiability, and the strong suggestion that the principal difference in outlook between Silverman and other workers in this area is in terms of the tasks they have used, rather than the overall interpretation placed on results.

Scanning, as Silverman has used the term, has not made interpretation of the proposed deficit particularly clear in terms of information processing conceptions of cognitive behaviour. As has been noted above (Chapter 1) scanning tasks refer to a wide range of human performance. The class of scanning tasks to which Silverman makes reference have been increasingly overshadowed by more methodologically flexible and rigourously defined measures (Erdeyli, 1974). Neale (1971) makes it clear that there is an ambiguous relation between size constancy or estimation tasks, and cognitive deficit, as well as a certain unreliability of empirical results (McKinnon and Singer, 1969) which makes adherence to the Silverman constructs somewhat difficult. There is also a lack of awareness of possible response lability in the particular tasks employed, which coupled with the short lasting deficit results, makes the situation more dubious , (Clark, Brown and Rutschman, 1967). Hence, while the scanning hypotheses are important as they relate to this thesis, the nature of the tasks utilized previously has produced unsatisfactory results, which in turn, has led to a search for a more reliable and flexible measure of scanning.

Conceptual Category Breadth and Studies of Overinclusion.

Norman Cameron (1938, 1939) was one of the first psychiatric researchers to relate the poor cognitive performance of schizophrenics, to attentional impairment. He referred to the schizophrenic patients' "inability to preserve conceptual boundaries" and used the term overinclusion to describe this.

Early studies which provided evidence for a primitive conceptual level for schizophrenics were carried out by Epstein (1953), Feinberg and Mercer

(1960), Kugelmass and Fondeur (1955), Lovibond (1954), Leventhal, McGaughran and Moran (1959), McGaughram and Moran (1956, 1957), McReynolds and Collins (1961), Meadow, Greenbatt, Solomon and Funkenstein (1953), and Zaslow (1950).

The main feature of overinclusion is an inability to exclude from a thought sequence, material that is irrelevant to the major theme of the thought. This theory is clearly related to that of McGhie and his colleagues (Hawks and Payne, 1972) and also to the Shakow studies. The focus is slightly different in that the tasks which are used for experimental purposes by Payne and his fellow workers are oriented towards measuring conceptual performance and are not based on RT data, or information processing schema.

The concept of overinclusion has been extensively studied by Payne and his colleagues. Payne, Matussek and George (1959) using a battery of overinclusive tests found evidence of schizophrenic deficit. Payne and Hewlett (1960) gave a large battery of tests, including overinclusive measures, and after factor analysis of the data, postulated a two factor theory of schizophrenic disorder. They proposed that some schizophrenic patients are abnormally overinclusive, while the remainder are slow and retarded in processing speed. This theory has been essentially confirmed in a number of studies using a variety of measures (Foulds, Hope, McPherson and Mayo, 1967, 1968; Hawks, 1964; Hawks and Marshall, 1971; Hawks and Payne, 1972; Payne, 1962, 1966, 1973;

Payne and Caird, 1967; Payne, Caird and Laverty, 1964; Payne and Friedlander, 1962; Payne, Friedlander, Laverty and Haden, 1963; Payne, Hochberg and Hawks, 1970). A major statement of the theory as it stands was made by Hawks and Marshall, 1971:

> "Overinclusive thinking and retardation in schizophrenia are both manifestations of the same basic attention defect. It is hypothesized that the condition of information overload, which results from schizophrenics inability to screen out extraneous sources of stimulation, is adjusted to in some cases by slowing the rate at which information is processed. Such cases show retardation but do not appear overinclusive. Schizophrenics who do not learn to retard the rate at which they process information will on the other hand appear overinclusive. It should follow then that experimentally increasing the rate of response of retarded schizophrenics should cause them to become overinclusive, whilst slowing the rate of response of overinclusive schizophrenics should diminish their overinclusiveness (p.81)."

It is clear that this theory is a blending of the findings of McGhie and Chapman on the slowness of processing, with the work on intrusions into response patterns carried out by the researchers on overinclusion. Such research has also been relatively productive in that it has produced such tests as the Payne-Friedlander tests of overinclusion (Hawks and Payne, 1972; Payne and Friedlander, 1962) and the Chapman Card Sorting Test (e.g., Chapman, 1956a, 1956b, 1958, 1961; Chapman and Taylor, 1957).

The validity and usefulness of these tests of overinclusion have been queried. Hawks (1964) and Watson (1967) have reported low correlations between tests of overinclusion, although Craig (1970) found slightly higher and significant results with the three most discrimnative tests from the Payne-Friedlander battery. Price (1968, 1970) investigated the concept of overinclusion and concluded that it may be too broad to have practical utility. Since the concept is so general, a diverse selection of tests have been used as measures of overinclusion. In particular Payne and Friedlander's (1962) suggestion that converted scores be summed across a number of different tasks and the total treated as measure of overinclusion seems somewhat dubious, especially in view of the low relationships obtained between the measures.

Payne, Hochberg and Hawks (1970) in their dichotic stimulation experiment used a carefully selected sample of schizophrenics, and found high intercorrelations on the Payne-Friedlander battery (confirming Craig's and Payne and Hewlett's conclusions). They suggested that failure to find significant correlations may be due to inadequate subject selection, and that these tests of thought disorder may only distinguish patients who show overt thought disorder from those who do not.

Overinclusion then, is a very broad label given to the results of a variety of tasks on which schizophrenics demonstrate some dysfunction. Further precise experimental definition of the notion of overinclusion is required, as well as a more rigourous understanding of the dynamics of the cognitive tasks being used. The idea of retardation, one commonly used in reference particularly to chronic patients also needs explication -

at what point in processing does this slowness occur, and why? A refinement in the understanding is needed before overinclusion can be confirmed as being a valid theoretical description of cognitive deficit.

Response Interference Theory:

A theory which emphasizes deficit of performance on conceptual tasks, and which has strong roots in Bleuler's (1930) notion of associative disturbance has been propounded by Broen and Storms (e.g., Broen 1968; Broen and Storms 1967; Storms and Broen 1972). Broen and Storms (1967) note that while competing responses are often evoked in normals, they usually remain dormant, and seldom intrude into response patterns. After a review of the literature Broen and Storms (1967) maintained that the difference between schizophrenics and normals:

> "...is seen as a partial collapse of response hierarchies. The strengths of competing responses are more equivalent, resulting in the fragmentation of dominant chaims of thought by the intrusion of competing associates (p.271)."

As Broen and Storms have suggested, this theory is similar to that of Lang and Buss (1965) whose interference theory, a very broadly conceived notion, implies that because of the irrelevant stimulus input and the subsequent inability to inhibit extraneous response patterns, schizophrenics show a consistent performance decrement.

While this theory is concerned primarily with conceptual performance, it may also be related to information processing tasks (e.g., Broen, 1968). Most theories propounded in this area stress the difficulties in gaining relevant information (e.g., Neale, 1971; Silverman, 1964a; McGhie, 1969) or in the processing of the relevant information (e.g., Yates, 1966a, 1966b). It is possible that difficulties in response organization may well play an important part. The relation between increases in response complexity, and increases in stimulus complexity, has not been systematically evaluated, and although the inferences from the data Broen and Storms present are limited, this aspect of information processing would appear to warrant further experimental investigation.

Perceptual Span Studies of Schizophrenic Deficit:

Some recent studies of the span of apprehension of schizophrenics have been performed which have added considerably to the understanding of cognitive deficit. As a response to conceptual problems with the tasks used by Silverman (Neale and Cromwell 1970), the perceptual span experiment was developed using Estes paradigm (Chapter 1), which involves a forced choice brief expsoure recognition task, where Ss are required to report which of two target letters was present on a given trial. Neale and his co-workers have produced some interesting results (Cash, Neale and Cromwell, 1972; Neale, 1971; Neale, McIntyre, Fox and Cromwell, 1969).

Neale et al. (1969) reported a preliminary study using acute, good premorbid paranoids, and acute poor premorbid nonparanoids, in which the target letter was presented either alone, or with seven 'noise' letters. The schizophrenics differed in the measure of probability correct, at the eight letter level of complexity, but not at the one letter level. The two schizophrenic groups did not differ at either level.

Neale (1971) extended these results using either 0, 3, 7, or 11 'noise' letters. As in the previous study the schizophrenics did not differ from the normals when only the one target letter was exposed, to be reported. As Neale reports:

> "Thus, the schizophrenics reached their processing limit of approximately two elements at Display Size 4, and showed no significant increase at Display Sizes 8 and 12. In comparison, the normals did not reach their limit of approximately 4 elements until Display Size 8 (p.202)."

Explanation for the results of these two studies was that schizophrenics' lower span of apprehension may be due to slow central processing (a notion which Cash et al. 1972, pointed out is similar to Yates' conceptualization). In a further study, Cash et al. found that neither of these two explanations was tenable. They reported a study using whole report procedures (Sperling, 1960), where the schizophrenics did not significantly differ from the normals in their performance. That is, when Ss were required to report everything they saw, the schizophrenic probability correct did not differ from that of the controls. They suggested that difficulty in rejecting irrelevant stimulus elements differences in actual processing strategies, or the differences in response requirements may account for the differences between this study and that of Neale (1971).

Spohn, Thetford and Woodham (1970) performed a span of apprehension study in which they varied the length of stimulus exposure, and in contrast to Neales' studies, kept the number of elements to be scanned constant. They found that as exposure time increased, the differences between groups also increased. Hence in both lines of research, the extremes of difficulty of the task (the least difficult end for Neale's study and the most difficult end for the Spohn study) schizophrenics do not differ, it is in the median range that differences become apparent. Ongoing work at Menninger (Spohn, Thetford and Cranco, 1970, 1971; Cranco, Sutton, Kerr and Sugarman, 1971) may well extend and develop this research further.

Arguing from this type of experimentation, as well as drawing together literature from a wide variety of fields, Cromwell (1972) has developed an overview of schizophrenia which is based on reactions to stimulus input. He discerns two patterns of schizophrenia which are somewhat similar to the chronic-acute, good-poor premorbid or process-reactive dichotomies. Those schizophrenics who tend to filter out all sources of stimulation and prefer an unchanging environment, he refers to as the "high redundancy" group. The patients who respond overinclusively, and prefer a greater variety of stimulation, he terms the "low redundancy" group. Cromwell lists a large number of signs which characterize the high redundancy group - the predominance of nonparanoid patients in this group, with hereditary factors, involved, poor premorbid adjustment, gradual onset of symptoms, generally stabilized symptomatology and poor prognosis (Deckner and Cromwell, 1970; Goldstein, Held and Cromwell, 1968; Held and Cromwell, 1968; Kety, Rosenthal, Wender and Schulsinger, 1968). Further, there is a strong preference for stimulus deprivation (Eisenman, 1965; Harris, 1959; McReynolds, 1963; Sidle, Acker and McReynolds, 1963), and such patients perform poorly after stimulus satiation (Mehl and Cromwell, 1969). The low redundancy group show the opposite patterns to those of the high redundancy group listed above, i.e. they have good prognosis and premorbid adjustment, and a strong dislike for stimulus deprivation. The high-low redundancy difference is particularly manifest in the ability of schizophrenics to sort the relevant from the irrelevant (e.g., Rappaport, Rogers, Reynolds and Weinmann, 1966; Rappaport, 1967; Cash et al. 1972). With these measures it is the high redundancy schizophrenic who is more severely disadvantaged than, the low redudancy group. Cromwell's theory then, which relates very closely to the work on overinclusion and to the results of McGhie, Shakow, and Silverman, presents itself as an informative conclusion to a large amount of literature and as a provocative challenge to the old subcategorizations of schizophrenia.

The Processing Theory of Yates:

The essence of the McGhie position outlined above was that schizophrenics are unable to filter out irrelevant stimuli, thereby putting an overload on the short-term memory (STM) system. From the work of Babcock (1930, 1933) and others, Yates (1966a, 1966b, 1973) has hypothesized that rather than being more easily distracted, the schizophrenic is unable to handle relevant information at the same rate as normals. Yates (1966a) points out that there are at least four points where breakdown may occur. It could occur at the receptor level where data is received; it could occur at the data processing level; it could occur at the cognitive or central processing level; or finally, it may occur at the level of the motor response. Yates proposes that in terms of Broadbent's filter theory:

> "...the basic defect of schizophrenia is as follows: first the rate at which information is processed by schizophrenics is abnormally slow. But if this is so, an inevitable corollary follows. Since the short-term memory system, by definition, can hold information for only a short time, the amount of stored information lost per unit time will be much greater than in normals (Yates, 1966a; p.128)."

If schizophrenics have difficulty processing relevant information then it may be assumed, that the more relevant information there is to process, the greater the dysfunction will become relative to normal performance. Court (1967), Court and Garwoli (1968) and Karras (1967) have noted that to substaniate Yates' theory, the lines relating RT to complexity should be nonparallel, for schizophrenics and nonschizophrenics. This has not always proved to be the case. Karras (1967) found that schizophrenics were slower than controls on a simple and two choice RT task, but that chronic schizophrenic performance did not deteriorate in the more complex condition. Court (1967) commented on the problems of Karras' experimental design and suggested that the result may not constitute a valid refutation of Yates' position. Court and Garwoli found parallel lines in an experiment which extended the Karras study to greater levels of complexity. They found that increasing complexity did not produce a disproportionately higher RT amongst schizophrenics. They concluded that these results did not detract from Yates' theory, and that this:

> "Interpretation is in accord with Yates theory that complexity of information input does not produce a greater deficit among schizophrenics unless presented under conditions where there is continuous pressure to respond (p.216)".

Yates (1966b) raised this idea of "continuous pressure to respond", and contended that if abnormally slow processing of relevant information persists over time, and the S is forced to make continual responses, then cortical processes will be adversely affected, resulting in response decrement and the appearance of bizarre response patterns. This interpretation is supported by the results of Slade (1971), using a continuous card sorting task (based on Crossman, 1953) who found that the more "bits" of information

(Attneave, 1959) to be processed, the greater the performance deficit of the schizophrenics.

Yates and Korboot (1970), and Korboot and Yates (1973), replicating a study by Harwood and Naylor (1963) found that increasing stimulus complexity differentially affected schizophrenic RT as compared to that of normals in a scanning-counting task. Yates used chronic and acute, paranoid, nonparanoid and neurotic Ss (six groups in all). The apparatus used was a tachistoscopic device where the Ss first pressed a button which provided illumination for the visual stimulus input, and then released the button when successful inspection and identification of the stimulus elements had been achieved. The Ss made a verbal response subsequent to cessation of illumination, and Korboot and Yates (1973) argued that they had attained a measure of pure inspection time, uncontaminated by verbal response time. The measure is not however uncontaminated by psychomotor response time, as time to switch off the apparatus is included in the response latency recorded. This method of allowing S to respond after display termination (a procedure used in the early experiments of Chapter 3) may also be confounded if Ss are able to complete scanning at an iconic or afterimage level.

The stimulus elements were either lines, symbols or two letter words, and the Ss were requested to report how many stimulus elements (from one to five) were present on each trial. The results showed that chronic nonparanoid Ss were significantly slower than all of the other groups for all three stimulus classes, except with the verbal material where both the acute and chronic nonparanoids performed markedly more poorly than the other groups. The raw data also shows that as stimulus complexity increased, RT increased, more rapidly for the chronic nonparanoids than for the other Ss.

A further hypothesis, generated by the Yates (1966a) paper was examined by Hawks and Robinson (1971). They tested the prediction that a reduced rate of stimulus presentation would enhance schizophrenic performance. Eighteen male chronic schizophrenic and nine normal Ss were asked under one condition (complete recall) to reproduce digits presented dichotically at three different rates of presentation, and under the other experimental condition (interference condition) to reproduce only those digits received through a designated channel. There were four different list lengths, and four presentations of each list length. The experimental results supported Chapman and McGhie's hypothesis. Schizophrenics performed slightly worse than normals in the situation requiring attention to one of two auditory signals, and the performance of the paranoids was better than that of the nonparanoids. A direct measure of attention to the irrelevant ear (i.e. the number of digits reproduced from the irrelevant input) showed that schizophrenics included more irrelevant digits in their response output. Neither the schizophrenics or controls were differentially affected by variations in the rate of presentation as Yates suggested. It is difficult however to accept this result as diminishing Yates position at all. The significant variable which Hawks and Robinson were manipulating may have been rate of decay in the STM, and not rate of information processing. That is, there is no control for length of time the processing takes place. The faster something is presented, the sooner it is over, and the less the possible decay in storage. Thus rate of processing is potentially confounded with rate of decay, and this reduces the potency of the results. Further, the manner in which ability to process input can be impeded by the emission of responses (as noted in the Treisman studies, Chapter 1) ought to be considered in a definitive acceptance of these results as support for Chapman and McGhie.

The Yates formulation is intrinsically valuable in that it relates modern ideas on cognitive functioning to schizophrenic deficit in an essentially provocative and heuristic manner. Since the two studies with schizophrenics to be reported in this thesis are concerned primarily with the effects of stimulus complexity on RT, the results and conclusions pertaining to this theory are of particular relevance. Yates' theory raises two basic issues - (a) what is the basis for the distinction between relevant and irrelevant information, and (b) to what extent is stimulus complexity independent of response requirements? These questions will be considered in detail below, in the conclusions to this section. However, several points may be introduced at this stage. A number of studies have shown that stimulus uncertainty (as defined by Smith, 1968) does not necessarily cause a disproportionate increase in RT between schizophrenics and normals (e.g., Court and Garwoli, 1968; Karras, 1967; Royer and Friedman, 1973; Russell and Page, 1974, in press). On the other hand, Yates and Korboot (1973) and Slade (1971) for example, found that as stimulus complexity increased, the schizophrenics RT increased more rapidly than that of some control groups. Some resolution of these apparently conflicting conclusions may be possible if one considers total task demands and the potential influence response organization and execution may have on overall processing time. This conclusion is advanced by Russell and Page, after considering several studies which show the way in which varying response demands influences the RT of schizophrenics (e.g., Karras, 1973; Marshall, 1973). This leads then to the suggestion that some reformulation and expansion of Yates model of functioning must be undertaken to accomodate all results and data available.

Conclusions:

When one surveys the literature relating to cognitive deficit, one is struck by the way in which the studies available lack an overall theoretical orientation, which builds their diversity into some coherent shape. Most theoretical explanations of deficit depend on the task which the experimenter and his colleagues have used. Thus if the formulation is based on the effects of distraction, tasks with distracting input are used; if on the other hand response mechanisms dominate the theory, then the experimental tasks will involve manipulation of response probabilities or hierarchies. Most experimental studies find that schizophrenics produce a deficient performance - sometimes this deficit is constant over a range of experimental manipulation, in other cases it may appear as if increasing task complexity differentially effects schizophrenic performance in relation to non schizophrenic controls. Some of the results are related to the theories of attentional structure reviewed in Chapter 1, often however deficit research has suffered due to the rapid obscelesence of formal theories of attention.

Kahneman (1973) identified two approaches to attention which are not intrinsically incompatible, and which may well be related to a discussion of schizophrenic deficit. He contrasts the structural model which postulates the existence of processing channels and structures (e.g., Treisman, 1969; or Broadbent, 1971) and the capacity model which utilizes such concepts as effort or arousal in an explanation which leans as much towards basic Psychoanalytic theory and psychophysiological arousal studies, as towards experimental cognitive psychology.

The limited capacity model Kahneman describes, postulates the existence of a circumscribed "quantity" of effort which is available for the maintenance and variation of attention. This theory might be extended to explain cognitive deficit not only in schizophrenia, but also in other psychiatric disturbances, by introducing the basic premise that capacity is reduced by certain mental disorders. Rabbitt (1968) working with geriatric patients has produced a similar idea which he develops using an analogy with the cognitive psychologists favourite explanatory device - the digital computer.

Rabbitt points out that there are three reasons why one computer may work more slowly than another, (a) computer size, (b) speed of functioning at an electronic level, and (c) organization of programming. Research thus far has shown that the schizophrenic computer-brain usually works more poorly than its nonschizophrenic counterpart. The researchers theorizing about schizophrenic defects have commonly related any dysfunction found to a specific structural level of the specific task they have used. Indeed this thesis is oriented in a similar manner. This means that tasks employing distraction have explained deficit in terms of distraction, and that tasks manipulating response complexity have provided theories in terms of response disorganization.

Our analogy with the computer however, suggests a potentially more global deficit may be operating. If the assumption is made that cognitive deficit results from an overall limited processing capacity, then a great quantity of the results can be collated. The limited capacity theory would state that because the schizophrenic "computer" is slower, smaller or less well integrated than the normal "computer", any performance which requires extended capacity at any level of task complexity will result in an apparent schizophrenic dysfunction. This implies that schizophrenics do not necessarily have slower RTs under certain conditions. It also creates a certain uniformity over various psychiatric disorders, since it can be argued that while capacity is diminished in chronic depression for example, this diminuation may not be as great as in schizophrenia.

If an explanation of attention is presupposed which allows for the concept of overall limited capacity, with schizophrenics' deficit being explained in terms of their having an even more limited potential for attentional effort than normals, what follows? One must first note that this formulation does not let a motivational interpretation in by the back door. In so far as motivation implies a voluntary control of attention, then it does not apply to a limited capacity model. Kahneman makes it clear that the ability to invest effort is not related to incentive in any consistent way. Whatever the positive or negative incentive there is a limit on human ability to perform a task. The principal advantage which this theory offers is the potential to reduce all information processing measures of attention to one continuous scale. This is achieved by regarding the task used as a whole in terms of the necessary expenditure of energy required to complete task performance. This is a very necessary endeavour in the schizophrenic deficit field where the variety of tasks employed is overwhelming. The only previous major attempt to construct meaningful descriptions of total performance requirements was provided by the work of the Information Theorists (Attneave, 1959). However, they achieved only variable success and Information Theory has been gradually neglected.

While the aims of a limited capacity model are admirable, can they be achieved? It is necessary not only to demonstrate the validity of a viable measure or measures of effort or capacity to pay attention, but also understand what makes one task more demanding than another. Kahneman suggests measures of attentional effort may be achieved by studying physiological aspects of arousal. Understanding task demands may best be attained by analysis of task structure as outlined in the previous chapter.

Yates (1973) makes a distinction between relevant and irrelevant information, and claims schizophrenics process the former more slowly than do controls. This dichotomy can be challenged however by asking when the irrelevant information becomes irrelevant - in order for S to make this judgement he must process the distracting input to some level. It is possible to extend Yates theory by maintaining that it is not just the relevant stimulus input which is important in determing performance, but also all other aspects of the task which require capacity for their processing. This includes ability to attenuate distraction, the complexity of the response, or the manipulation of the necessary stimulus inputs. Yates (1966b) in fact implies this extension when he discusses continuous pressure to respond. Thus, whatever aspect of the processing procedure which is manipulated, the result will be the same - when capacity is exceeded performance suffers. The threshold is lower in psychotics, thus performance decrements become more apparent, more rapidly with these Ss. This theory of limited processing capacity in schizophrenia must remain tentative. In a sense it may be too strong an explanation of cognitive deficit since it accounts for most of the results of studies available. To be heuristic, and meaningfully predicitive, a valid link between cognitive measures of attention and psychophysiological arousal studies is necessary, and at present this connection can only be described as tenuous.

PART 2 METHODOLOGICAL PROBLEMS AND SCHIZOPHRENIC COGNITIVE DEFICIT RESEARCH.

> "Shortly before the turn of the century the famed pathologist Rudolph Virchow was asked for a definition of cancer. He responded that he would not attempt such a definition even under the threat of torture. His very sensible position is equally applicable to schizophrenia (Cranco, 1973; p.693)."

Introduction

The increasing maturity of the research with schizophrenic Ss can be guaged by the number of reviews which have been published demonstrating a concern for the methodological problems involved (e.g., Cash, 1973; Cromwell, 1972; Lang and Buss, 1965; Schooler and Feldman, 1967; Strauss, 1973; Zimet and Fisherman, 1971). All the issues raised by these reviews will not be discussed in this survey, however some attempt will be made to investigate some of the major difficulties facing the successful and meaningful accomplishment of the two experimental studies to be described in this thesis. Considerable problems are raised by the question of subject selection, the definition of the sample, and the representativeness of the patients used (e.g., Ralph and McCarthy, 1967). This leads to an awareness of the difficulty of attributing any performance difficulties on the tasks used to psychological deficit rather than to extraneous, confounding effects.

The Representativeness of the Sample:

One key problem facing research on schizophrenic deficit has always been defining the sample of Ss used. Most experiments use a selection of patients who are not necessarily characteristic of the total schizophrenic population. In order to minimize possible differences due to irrelevant factors, Ss who have brain damage, are on ECT, have a secondary diagnosis, or are hostile and uncooperative are usually eliminated from the study. Ralph and McCarthy (1967) have concluded that in order to obtain a tightly controlled group of schizophrenics, too often it is necessary to be so specific in S selection that meaningful generalization is impossible from the results of the research.

Klein and Spohn (1964), Ullman (1961), and Wilensky and Solomon (1960) have commented on the problem of the untestable chronic schizophrenic group. These researchers have found that in some ways untestable Ss vary from testable psychotics, implying that the group of Ss used most frequently for research in this area may be atypical. It should be borne in mind however that the group tested will probably perform better than the untested Ss who refuse to cooperate, and in this sense, the confounding is conservative.

The Effects of Drug Administration:

The usefulness of phenothiazine for schizophrenic Ss has been continually substantiated since the introduction of this treatment in the early 1950s.

This means that in the majority of research with such patients, confoundings due to drug administration will be common, and must detract from the strength of the results. Cash (1973) has noted that only about sixty percent of the studies which he reviewed mentioned whether or not their patients were medicated.

One solution to the problem of this confounding may be to use unmedicated patients (e.g., Spohn et al., 1970). Only eight percent of the studies reviewed by Cash (1973) reported doing this. However, withdrawal of medication may result in a high lapse rate and a consequent high percentage of untestable Ss (e.g., Blackburn and Allan, 1961; Diamond and Marks, 1960; Good, Sterling and Holtzman, 1958). Also, termination of medication is difficult to arrange in any psychiatric hospital, and many researchers feel that the high probability of recurrence of symptoms does not justify the procedure. Further biases are likely to occur when only unmedicated patients are used, as these patients tend to have less severe disturbances (Chapman, 1963).

Since the patients who were used in the two experiments to be described were in most cases receiving phenothiazine antipsychotic drugs, an attempt will be made to evaluate the effect of this treatment on task performance. The literature on the efficacy of the phenothiazines is vast and no attempt can be made to review it here, particularly as many extensive and informative reviews exist at present (e.g., Cole and Davis, 1969; Teece and Cole; 1972; Klein and Davis, 1969; May, 1968).

(a) Medication and Chronicity:

The administration of phenothiazines has dramatically influenced the course of illness of schizophrenics, particularly the poor premorbid Ss (Cromwell, 1972; Strauss, 1973; Goldstein, 1970). Chronicity is frequently measured in terms of length of illness (LOI), or number of years of hospitalization (LIH). Brown (1960), reviewing surveys of patients admitted from 1900 to 1951 found LIH correlated highly with LOI, and that after two years of hospitalization, discharge rates tend to stabilize. This has probably changed radically (e.g., Yolles and Kramer, 1969). Patients are far more likely to spend a larger number of short periods (less than six months) in hospital than previously. This means that measures of chronicity in terms of such temporal measures as LIH and LOH are strongly confounded not only by socioeconomic factors, but also by degree of response to phenothiazines. Strauss (1973) makes this point:

> "Long-term hospitalized Ss and long-term ill but only intermittently hospitalized Ss differ in significant ways. The latter become rehospitalized as a function of psychosocial characteristics and their failure to continue taking ataractic drugs (Crumpton, 1965; Paul, 1969; Rosen, Englehardt, Freedman, and Margolis, 1968). The continuously hospitalized Ss, among other things, have not responded to phenothiazines more than minimally (p.273)."

(b) Phenothiazines and Psychological Test Performance:

Several reviews of the somewhat limited literature available in this field (Baker, 1968; Hartlage, 1965; Uhr, 1960) stress that Chlorpromazine (CPZ) is an effective tranquilizing agent and administration of this drug results in better performance on tests of intellectual functioning (e.g., Abrams, 1958; Castner, Covington and Nikols, 1958; Kovitz, Carter and Addison, 1955). No effects of drugs on the Rorscharch (e.g., Belmont, Pollack, Willner, Klein and Fink, 1963), the Draw - a - Person Test (Gross, Hitchman, Reeves, Jordan, and Bacon, 1963), the Bender - Gestalt (Heilizer, 1959) and the Minnesota Multiphasic Personality Inventory, MMPI (Gibbs, Wilkens, and Lauterbach, 1956), have been reported. The ameliorative effects of drugs as measured by tests of intellectual functioning seem to be confined only to patient populations, or to patients with disturbed thought processes (Kornetsky and Orzack, 1964). Facilitation of cognitive function appears to be more pronounced undeṛ dosage levels of 200-600 mgm CPZ and after one to four months of treatment.

With reference to forms of testing not using the standard intelligence scales, Baker (1968) concludes that:

> "Studies evaluating the effects of CPZ on other areas of functioning are more ambiguous. With very few exceptions test performance either improves or does not change after treatment of at least two weeks duration. Side effects of the drug may interfere with test performance in the early stages of treatment but no further drug-interaction effects can be noted (p.380)."

(c) Phenothiazines and Measures of Attention.

The results of treatment with phenothiazines as they relate to attention deficit has been poorly researched. Most studies show however that except for initial weeks of treatment, performance is either improved or at least not altered by drug administration to schizophrenics. For example, Owen (1971) assessed schizophrenics, on tests of brain damage, attention and perceptual distortion at four stages of treatment; (a) within 48 hours of admission, prior to medication. (b) after 4 - 6 days of medication, (c) after 5 - 9 days of medication, and (d) after 15 - 20 days of medication. Test impairment was found only during the first week of medication and not at the other stages. The well documented side effects of phenothiazines during administration suggest that some caution should be exercised in assessing results from studies conducted on patients newly admitted and recently placed on medication.

One of the best researched areas in this field concerns the effects of phenothiazine medication of auditory signal detection in schizophrenics (Loeb, Hawkes, Evans and Alluisi, 1965; Rappaport, 1966, 1967; Rappaport and Hopkins, 1969; Rappaport, Hopkins, Silverman and Hall, 1972). They found that as the phenothiazine dosage is increased the signal detection (d') scores of nonparanoid schizophrenics decreased, while the scores of the paranoid schizophrenics increased (Rappaport et al., 1972). Without medication nonparanoids performed more efficiently than paranoids, but the performance of the nonparanoids deteriorated as dosage increased. Taken together with data from Goldstein, Judd, Rodnick and LaPolla (1969), Goldstein (1970) and Magaro and Vojtisek (1971), these results suggest that acute good premorbid paranoid patients, when treated with phenothiazines, show lessened thought disorder and improve focal attention as compared with paranoids on placebo; acute, good premorbid nonparanoids, without phenothiazines show less thought disorder and improved focal attention as compared with phenothiazine treated nonparanoids. Differential effects of phenothiazines on performance of paranoids and nonparanoids are also reported by Interbitzen, Buchsbaum, and Silverman (1970) and Fischer, Risetine, and Wisecup (1969). Rappaport et al. (1972) in line with Silverman's (1969) theoretical work, conclude that paranoid schizophrenics have a primary disability in focal attention (and are relatively hyposensitive), and that medication primarily improves their ability to focus attention and respond to auditory signals. Nonparanoid schizophrenics, on the other hand, are hypersensitive to stimulation and medication reduces their hypersensitivity and consequently their ability to detect and respond to signals.

Schooler and Goldberg (1972) report a large study using 480 acutely ill patients who were studied for 26 weeks, using both clinical assessment and a performance test battery, at four points in time; prior to the start of treatment, and 5, 13 and 26 weeks after initial drug administration. The test battery included RT, a similarities test, sway suggestibility, a vocabulary test using emotionally toned words, a measure of perceptual uncertainty (estimating number of dots in tachistoscopic presentation together with a measure of subjective uncertainty), and a series of ratings by the experimenter. No control for practice effects, and no normal or non schizophrenic controls were used. Data was examined in terms of change over time, and relationship to ratings of clinical symptoms. It was found that most changes in performance occured during the first period of five weeks, although rated behaviour improved over all 26 weeks.

Kornetsky (1972) has reported a number of studies showing how use of the Continuous Performance Test (CPT) can assess the effects of medication on continuous attention (Kornetsky and Mirsky, 1966; Mirsky and Kornetsky, 1964; Rosvold, Mirsky, Sarason, Bransome and Beck, 1956). This type of experiment is similar to the Neisser (1963) task, but the speed of presentation is controlled and Ss are required to report presence of a target letter when a series of letters are displayed continuously. These researchers have found clearly that the number of schizophrenic Ss whose performance is within the range of normal Ss increases significantly when they are on phenothiazine medication (Orzack and Kornetsky, 1966). This sensitivity is also reported in animals (Kornetsky and Bain, 1965), who found that dosage levels were correlated with errors committed. There appears however to be no relation between schizophrenic subtype and the CPT; and there is no relationship between length of hospitalization and performance. Patients who do poorly on the test improve if treated with phenothiazines, and practice effects seem to be minimal (Kornetsky, 1972).

Using associative gravity, perceptual defense, and Galvanic Skin Response (GSR) of drug effects, it was found (Goldstein et al., 1969) that only skin resistance showed reliable drug-placebo differences. Payne (1972) reports an unpublished study by Payne and Friedlander using chronic schizophrenics with an average hospitalization of approximately 12 years. The patients were taken off drugs for six weeks, and about twenty five percent of the patients became untestable, or were put onto drugs again because they became too disturbed to manage in the ward. Ss were then tested, under conditions of high, moderate or low distraction for simple auditory RT. These chronics were very slow, and the introduction of distraction did not increase RT. The patients were then divided into two groups who received either Proketazine, or placebo, in a double blind situation. Retest after six weeks showed that proketazine did not improve performance although under two of the four experimental conditions patients receiving placebo improved in performance. Similarly Pugh (1968) found that an experiment with chronic schizophrenics suggested that with longterm chronic patients, phenothiazines do not improve performance; although controlled studies of these affects using reliable measures are few and far between.

Experiments using size estimation are also confounded by anti-psychotic drugs (McKinnon and Singer, 1969; Zahn, 1959). The pervasiveness of drug confoundings led Spohn (1972) to suggest that the relationship between drug variance and psychological deficit might profitably be examined. He suggests that use of measures of the time-course psychological processes in which deficit is suspected to be studied in parallel with the time-course of effects upon symptoms and morbidity. Another strategy which might be used is the stepwise increment of drugs both forwards and backwards over a period of time which could be related to performance on psychological measures of attention.

(d) <u>The Phenothiazine Drug Index (PDI)</u>:

Since phenothiazine medication is known to interact with physiological functioning, Spohn, Thetford and Woodham (1970) were concerned that they be able to estimate the effects of drugs on span of apprehension and the psychophysiological measures they employed. They developed the PDI to measure the effects of drugs on these scores. The total daily dosage was expressed as a proportion of weight in kilograms multiplied by the relative potency of the medication used to chlorpromazine, i.e., PDI = (total daily dosage/weight) x (drug potency relative to CPZ). Spohn (personal communication, 1972) recommended

TABLE 2-1

Antipsychotic Drugs Available in the United States of America. From L.E. Hollister, "Choice of Antipsychotic Drugs," American Journal of Psychiatry, 1970, 127, p.187. Brand names in parentheses.

Phenothiazines	Estimated Equivalent Dose (mgm)
Aliphatic	
Chlorpromazine (Thorazine)	100
Trifluopromazine (Vesprin)	25
Piperidine	
Thioridazine (Melleril)	100
Piperazine	
Acetophenozine (Tindal)	20
Butaperazine (Repoise)	10
Carphenazine (Proketazine)	25
Fluphenazine (Proloxin)	2
Perphenazine (Trilafon)	10
Prochlorpromazine (Compazine)	15
Thiopropazate (Dartal)	10
Trifluoperazine (Stelazine)	5
Thiozanthenes	
Chlorprothixene (Taracton)	100
Thiothixene (Navane)	2
Bulyrophenone	
Haloperidol (Haldol)	2

that except where the drugs are known to act synergetically, where more than one phenothiazine is used, the PDI for each drug be combined additively.

It was decided to use the PDI for this present study, for although this measure is not an optimal solution to the problem of medication confoundings, it represents an attempt to evaluate possible effects. The relative potencies used (reproduced from Hollister, 1970) are outlined in Table 2 - 1.

<u>Paranoid Status:</u>

The division of schizophrenic Ss into paranoid or nonparanoid groups is common (Lang and Buss, 1965; Silverman, 1964, 1967; Ullman and Krasner, 1969). This is particularly true of the work with scanning and size comparison performed by the Menninger Group. Paranoid schizophrenics are said to form a homogeneous group (Mayer-Gross, Slater and Roth, 1970) and are characterized by "the presence of persecutory or grandiouse delusions, often associated with hallucination (American Psychiatric Association, 1968; p.34)". Generally they are seen as less disturbed cognitively (Silverman, 1967) than nonparanoids.

Three research methods are commonly used to differentiate paranoid and nonparanoid patients: (a) Official hospital psychiatric diagnosis. This is often very variable and based on differing criteria between hospitals and even between psychiatrists in

the one hospital (e.g., Davis, Cromwell and Held, 1967; Payne and Caird, 1967).
(b) Self Report using the MMPI or the Symptom Sign Inventory, SSI (Gordon, 1970; Ullman, 1958), and
(c) Behaviour ratings on the presence of specific symptoms, for example hallucinations as in the Johanssen, Friedman, Leitschnle, and Ammons (1963) study.

Relatively low correlations amongst these three methods (Calhoun, 1971) illustrate the need for a clearly defined method to be explicity stated in dividing schizophrenics in this way and a need for consistency across studies. Obviously differences in group composition can lead to differing conclusions between studies.

In the studies reported in this thesis a rating scale of the self report type (Gordon and Gregson, 1970) was used. This provides 11 items, drawn from the SSI (Foulds, 1965) which best differentiate paranoids and nonparanoids, and which are weighted according to their degree of significance in determining paranoid status. While the Gregson - Gordon study was based on only 18 paranoids and 18 nonparanoids, and has never been crossvalidated or revised subsequently, the test is easily and quickly administered, and was standardized on a sample taken from the hospital from which Ss were drawn in the later experiments (Chapter 5 and 6). The scale they developed was used in the present studies in conjunction with the psychiatric diagnosis provided by the psychiatrists response for the S used.

The Chronicity Dimension

The commonest dichotomy into which schizophrenic patients are classified is the process-reactive distinction. Schooler and Feldman (1967) list 85 studies of a total of 990 which compared these two classifications as well as a further 45 which used the chronic-acute differentiation as basis for comparison. It is proposed in this thesis to use the terms process and reactive in preference to acute and chronic for the following reasons:

(a) The greater use of process and reactive, and the larger historical use of these terms.

(b) The fact that acute (and also chronic) are often used to describe a phase of illness. Most patients - process or reactive - tend to enter an instituition in an acute phase, which maybe a response to withdrawal from medication, the climax of many years steady deterioration, or an acute sudden onset as a reaction to some environmental or social stress. Researchers who take newly admitted patients, clearly in an acute phase run the risk of including in their sample patients whose life history reveals them to be long term process schizophrenics.

(c) There is also a tendency to regard chronicity as being directly related to length of hospitalization, rather than being a reflection of early onset, poor prognosis, and poor premorbid social and sexual adjustment.

(d) There exists no measures of chronicity or acuteness, in the form of rating scales or agreed definitions of the term - apart from such arbitrary criteria as two years hospitalization. Most research which has been done into the chronicity dimension has concerned itself with process and reactive schizophrenics, and several rating scales, although limited in validity and reliability have been devised and extensively used, especially for research purposes.

(a) Introduction:

Several comprehensive reviews of this field exist, (Higgins, 1964; Valliant, 1964b; Allon, 1972; Garfield and Sundland, 1966) and hence this review of the literature will be brief.

In general, despite the notorious heterogeneity of schizophrenic patients, a continuum has often been described with the end points being labelled "process" and "reactive", to render the conceptualization of schizophrenia a more orderly affair. The process schizophrenic may be characterized as having a poorly integrated premorbid and personality adjustment with marked schizoid tendencies. Usually there is an insidious onset of psychosis with a relative absence of any precipatating stress, either social or psychological. Clinically, affect appears indifferent or blunted and there is relative absence of confusion. Prognosis is generally poor.

The reactive schizophrenic however has typically experienced a rapid onset of psychosis and there are usually realistic stresses to which the abrupt onset may be attributed. While premorbid adjustment is often neurotic, it is seldom schizoid, and there are noticeable affective components in the patients presenting symptoms. The commencement of the psychosis is usually accompanied by severe confusion and prognosis tends to be relatively good.

The earliest reports that schizophrenia may not lead to inevitable deterioration and dementia can be attributed to Haslam (1809) and Esquiral (1838). Descriptions of reactive type patients whose symptoms remitted are presented also by Bell (1849), and Griesinger (1867). Kraeplin (1919) noted that the prognosis was more hopeful for patients whom he described as having Catatonic excitement - with a stable premorbid history. In the 1920s Bleuler took Jasper's (1913) distinction, and hestitantly used the terms reactive or situational psychoses as opposed to process or progressive psychoses. With the work of Langfeldt (1937, 1939) and Kant (1940, 1941a, 1941b) a number of criteria were established which were held to be related to a good prognosis in schizophrenia. It should be noted that both these clinicians were dubious about the authenticity of reactive schizoprenia - Langfeldt used the term schizophreniform psychosis - and there was a general feeling that the reactive type of schizophrenia was either an undiagnosed manic depressive or affective disorder, or else not a "true" dementia praecox.

The acute, reactive schizophrenic disturbances have long been the subject of much controversy, and it is often held that they are not truly schizophrenic. Valliant (1964a) in his excellent historical review notes that despite widely differing labels (e.g., Hoch 1921, "Benign Stupor"; Kasanin, 1933; "schizoaffective" psychosis; and Medina, 1950, "Oneirophrenia") the authors appear to be describing a number of syndromes with very similar manifestations, which might be subsumed under the all embracing rubric of "reactive schizophrenia". He concludes that:

> "Although in certain respects the pictures did resemble manic depressive psychosis or toxic states, during the acute episodes the pictures are certainly compatible with Bleuler's group of schizophrenics, entity or no entity. Like the chimera of antiquity the disorder under scrutiny is a composite. That the Body is a head consisting of a good premorbid life adjustment, an acute stress precipitating the illness and often an heredity positive psychotic depression. The tail that follows after includes a remission to the best premorbid level of adjustment and occassionally a history of subsequent psychotic depressive breaks (p.55)."

(b) <u>The Rating Scales</u>:

The principal product of research concerned with the process-reactive dimension has been a plethora of scales and definitions. Some of those which have appeared include the Elgin Scale (Wittman, 1941), the Phillips (1953) Premorbid Scale, the Kantor Scale (Kantor, Wallner and Winder, 1953) the MMPI Ego Strength Scale, (Barron, 1953; Herron, 1962) the Process-Reactive Questionnaire (Ullman and Giovannoni, 1964), Rorscharach scores (Kantor and Herron, 1966), an unsuccessful MMPI scale (Johnson and Holmes, 1967), the Stephens and Astrup Criteria (1961), and the Symptom Checklist (Phillips and Rasinovitch, 1958).

The Elgin Scale, which is commonly used, was presented as an ordinal rating scale of prognosis in schizophrenia by Wittman (1941). Wittman (1944) and Wittman and Steinberg (1944) reported a high prognostic efficacy for the scale with large patient samples. The scale was revised (Becker, 1956), factor analyzed (Becker, 1959) and further abbreviated (Steffy and Becker, 1961). Encouraging predictive validity was reported by these researchers. Factor analysis by Lorr, Klett and McNair (1963) revealed three certroid factors: (a) schizoid withdrawal, (b) reality distortion, and (c) a vaguely defined rigidity or inadaptibility factor. Chapman, Day and Burnstein (1961) however, while they found a statistically significant validity coefficient for the scale after six months admission, reported that only 11 items contributed to this correlation and that marital status alone predicted almost as well as the total scale.

The Phillips Scale (1953) attempts to evaluate the patient in terms of premorbid history, possible precipitating factors and clinical signs of disturbance. The first section of the scale, comprising five items pertaining to premorbid history, has been the subject of much research. Although the score was developed for males only, it has been used with females with only minor modifications (Farina, Garmezy, Zalnsky and Becker, 1962). Phillips in his original paper did not provide any scale norms but indicated the general significance of the different items' scores in his discussion of the scale. Using the shortened form of the test, Chapman and Baxter (1963) used a score of 15 as the beginning of the "poor premorbid" category and scoress less than 15 were grouped as "good premorbid". Considerable variability is evident however in the criterion used, but as

Garfield and Sundland (1966) note, the score of 15 is most frequently used.

The Kantor scale (1953) uses 24 "either - or" questions distributed among four developmental periods to discriminate between reactive and process schizophrenics. Theoretical discussions of the of the criteria used are provided by Kantor and Winder (1959, 1961). However no quantitative ordering of the variable is attempted, the dimensions are often descriptively vague, and the scale depends on life history material often unavailable, and rarely possible to substantiate. This scale is largely useful as a guide for making a qualitative clinical decision.

The Phillips, Elgin, and Kantor scales are all rating situations in which the user rates the patient on the variable: usually on the basis of his life history and case history data. Herron (1962a, 1962b), recommends scales in which patients themselves provide the ratings. The Barron Es scale has been used in conjunction with the MMPI (Herron, 1962b) but this is not common practice. Another scale is the Ullmann and Giovannoni (1964), Self Rating Scale which uses 24 "true-false" items to distinguish between process and reactive schizophrenics. Its validity is reduced by the fact that it was standardized on an all male sample, and it is also noticeable that those items which most highly correlate with a reactive classification are concerned with marriage, fathering a child and ongoing heterosexual relationships.

Comparison of the scales has been attempted only a few times - due to the difficulty of scoring some scales and on agreeing on the meanings of the variables to be rated. Johannsen et al. (1963) compared the Kantor Scale with the Phillips Premorbid Scale, with judgements on the former scale being made in terms of a five point bipolar scale. They found a tetrachoric correlation of 0.62 between the scales. Solomon and Zlotowski (1964) compared the Elgin and the Phillips and found a correlation of 0.78. Nuttall and Solomon (1965) using the Elgin Scale (Becker, 1956) and the Phillips, rated 291 patients and factor analyzed the results. Correlating the factors with chronicity, they found (a) Social withdrawal and lack of interests, (b) inadequate heterosexual relations, (c) socially undesireable ward behaviour, and (d) insidious onset, to be the factors best related to the process - reaction distinction.

Watson and Logue (1969) compared the Phillips, marital status, the Ullman - Giovannoni scale, the Elgin scale, length of hospitalization, Ego Strength, and Educational achievement, and concluded that the Elgin, Phillips, Ullman - Giovannoni scales, together with marital status are probably appropriate to process-reactive distinctions. Length of hospitalization, age and education did not serve as an adequate measure. They note that since the interjudge reliability of the Phillips and Elgin scales is dubious (Watson and Logue, 1968), marital status and the Ullman - Giovannoni scale may provide the most reliable operational definitions available.

Garfield and Sundland (1966) compared the Elgin, Kantor and Phillips scales on females and found all three had a moderate degree of relationship to each other. However when various cut off scores were used, prognostic efficiency tended to fluctuate. They found also that marital status alone predicts length of hospitalization as well as any of the scales. This finding contributes to a great bulk of literature in this field which notes the influence of social factors on process-reactive classification. Jenkins and Gurel (1959), Lindeman, Fairweather, Stone, Smith, and London (1959) and Mason Tarpy, Sherman and Haefner (1960) found that length of hospitalization could be predicted by marital status with male patients and this finding was replicated amongst female patients by Farina et al. (1962) and Orr, Anderson, Martin, and Philpot (1955). Chapman et al. (1961) notes that the Elgin scale is markedly correlated to marital status, as is also the Phillips and Ullman-Giovannoni.

Hence, it is apparent (a) that marital status is an effective predictor of hospital stay, and (b) most scales rely heavily on marital status for predictive validity. The importance of marriage may be a reflection of premorbid personality integrity, or it may be that the social roles pertaining to marriage - wage earning or housekeeping lead to a greater pressure for hospital release.

Significantly higher proportions of Negroes are labelled "process" than white schizophrenics (Lane, 1968). Male negroes fare worse than females. As Lane notes, this could be due to interview bias, a lack of cultural continuity in symptom patterns or a possible environmental aggravation on the symptomatology of the mainly lowerclass Negroes. Becker (1956) found significant differences between male and female Ss on the Elgin, with males more likely to be process than females. A significant inverse relationship between socioeconomic status (SES) and scores on the Phillips was found by Chapman and Baxter (1963) in two of their three samples. These findings were systematically investigated by Allan (1971). He divided patients into Process and Reactive subcategories using the Symptom Check List and correlated this with sex, race, SES and social mobility. He found that the process rating was more likely to be given to males, blacks and Ss with a low SES. It seems clear that the rating scales used have systematical biases, although whether these are entirely artifactual is not clear. Certainly the criteria used to validate them may not be adequate especially when length of hospitalization is used - since social factors, age, job potential, intelligence, race and marital status may militate against early release.

One of the problems of testing comparability between scales is that scales were developed using varying predictive criteria - e.g., differential response to ECT (Wittman, 1941), differential response to the Rorscharch (Becker, 1956; Kantor et al., 1953), and differential life history data (Kantor et al., 1953;

Phillips and Rabinovitch, 1958). Also, interrater reliability maybe low and certainly varies - e.g. reliability for the Elgin Scale has been o.5 (Watson and Logue, 1968), 0.82 (Garfield and Sundland, 1966), and 0.87 (Wittman, 1941). A similarly varying range is reported for the Phillips (Farina et al., 1962; Garfield and Sundland, 1966; Watson and Logue, 1968). While factor analysis of the Scales (Becker, 1959; Lorr et al. 1963; Nuttall and Solomon, 1965) suggest a certain amount of the small variance between measures is in common, the question of differential sensitivity of various scales to the process-reactive dimension and to correlates of this dimension (Garfield and Sundland, 1966; Johnson and Ries, 1967; Solomon and Zlotowski, 1964; Watson and Logue, 1968, 1969) which may or may not be artefactual would appear to be an important direction for research.

(c) Conclusions:

Overall, the standard of research endeavour with these rating scales has been somewhat indifferent, although many studies showing the limitations of proposed scales have been more useful. Unfortunately it has proved all too easy to design a study which will throw doubt on such clinical scales. The emphasis in designing the scales has been on providing a basis for a qualitative clinical decision rather than a quantitative rating which could be objectively and independently verified.

However, a great need remains for these scales and for the type of data they provide, amongst researchers investigating cognitive disturbances in schizophrenia. Without such scales little possibility exists for attaining some degree of comparability between the schizophrenic samples of one researcher and those of another. It is clear that these scales are not as efficient as they might be, partly because individual items are not weighted according to empirical and statistical evidence (there is no clear reason why scores from 0 - 6 have been given on the Phillips), and partly because an adequate validity criterion is hard to find. Length of hospitalization is not independent of the influence of SES, race, sex, and marital status, and baldly stated cut off points e.g., "two years hospitalization", should not be used as chronicity criteria. A patient who is reasonably intelligent, is maintained by a regimen of psychotropic drugs and lives in a well structured social or family environment is not likely to spend much time in hospital; whereas a less intelligent patient with a low standard of work skills is likely to spend a disproportionate amount of time in hospital. Continual deterioration of the patient until he is finally completely institutionalized and banished to the back wards is less common with the use of phenothiazines and more community based therapy programmes. Hence distinction between process and reactive may be more meaningfully defined in terms of social, heterosexual adjustment, pattern of onset of symptoms and disturbances of affect.

Finally, it should be noted that all the scales discussed were developed in the U.S.A. There is reason to suspect that they should be modified and adapted for use in New Zealand (N.Z.) especially when many of the scales depend of sociological norms which may not apply in N.Z. Most scales are designed for use with case history data, and plenty of this is available and suitable for use, and for development of multivariate predictive models to determine prognosis, which could be geared to individual hospitals with individual treatment programmes. This is an area in which there is a sad lack of data in the New Zealand health service.

(d) Use of Scales in the First Experiment:

The patients used in the first experiment to be reported below all inclined towards the process end of the hypothesized chronicity continuum. Some were more clearly long term process patients than others, none were considered to be reactive schizophrenics.

Chronicity was measured using three criteria:

(a) The Full Scale Phillips Premorbid Scale - data was later broken down, and the scores from the first five items used as well.

(b) The Stephens and Astrup Checklist of criteria for prognosis and definition of process patients. The total number of process signs and the number of process signs minus the number of nonprocess signs was computed. This is a dubious procedure as it is not clear that all symptoms have an equal weight in determining a process pattern, and conclusions based on this scale were interpreted with considerable caution.

(c) Length of Hospitalization. This was expressed as a number of years, and also as percentage of Life in Hospital (% L.I.H.) as used by DeWolfe (1968).

Chronicity was thus taken to be a continuous variable and was treated accordingly in correlational analyses computed in the first experiment.

Measurement of Intelligence:

Since it was felt that intelligence might influence results on the performance tests used in the first experiment (Chapter 5) it was decided that some scale which would measure this variable would be used. The WAIS, which is a well standardized and validated test usually provides scales which give a brief intellectual assessment. There is considerable evidence that some intellectual impairment maybe a result of a psychotic illness (Payne, 1960; Yates, 1954, 1966a; Granick, 1963; Friedman, 1964). Although its use has been criticized (Yates, 1954, 1966a) vocabulary has been found to be the subtest with the least evidence of deterioration in schizophrenia (Payne, 1960). This was supported by the results of a study carried out at Sunnyside Hospital (from which Ss for the schizophrenic experiments were drawn) which showed that Vocabulary (mean 10.37) had the highest mean score (followed by Information, 10.11; Comprehension 9.41; and Digit Span 8.82). The data for this study was compiled from psychological reports from

1969 to 1971; and 112 schizophrenic WAIS profiles were recorded (McPherson, 1973).

In an attempt to shorten the period of testing, it was decided to use the abbreviated version of WAIS vocabulary (Jastak and Jastak, 1964). This revision has high reliability compared to original scale, is more readily scored, and correlates highly with the old Wechsler scale ($r = 0.95$).

CHAPTER THREE

SAME - DIFFERENT REACTION TIME TO RANDOMLY CONSTITUTED MULTIELEMENT DISPLAYS

> "It is too early to know whether what I am calling the cognitive revolution is really that or whether psychological theory has come the full circle. Be that as it may, what is clear is that cognitive concepts have begun to pervade many areas of psychological theory (Dember, 1974; p.161)."

The aim of the pilot studies to be reported in this chapter was twofold. Firstly it was necessary to find a task that was useful and practicable for the study of information processing in schizophrenia. Secondly, it was decided to develop and extend the results from the type of task used by Donderi (Donderi and Case, 1970) by using letter stimuli. The task which Donderi has used (see Chapter 1) involved Ss scanning randomly placed geometric figures, coloured dots or pictures to determine whether each stimulus element was the same, or whether one of the elements (designated target elements in the present study) was different. Donderi found with the above stimulus classes over the relatively small range of visual angle of from 5° to 10° in both horizontal and vertical planes that the area in which the shapes appeared did not affect speed of correct response, any more than did the number of elements presented (between 3-14 elements). However with letters he did not find any evidence of parallel processing (Donderi, personal communication, 1972). Egeth, Jonides and Wall (1972) using a limited number of letter stimuli (up to 6), in a non random display, found that in some situations, increasing the number of letters did not cause a subsequent increase in RT.

The present experiments extended this research in two basic ways:

(a) The number of element letters to be scanned was varied from 10 - 40 in Experiment 3-1, and from 3-60 in Experiment 3-2.

(b) A larger set of targets and nontargets was used than in either of the Donderi or the Egeth studies.

The first study was concerned primarily with the different response data and in differences in response latency due to, (a) the number of elements to be scanned, (b) the distinctiveness of the target elements against the background elements, and (c) the number of target elements. In Experiment 3-1, the ratio of same to different stimuli was 1 : 5, however with Experiment 3-2, same and different stimuli were equiprobable. The principal concern of Experiment 3-2 was to examine in more detail the relationship between the same and different response curves, where only one different target element was possible. The separate aims of each are discussed in more detail below.

Experiment 3 - 1

(a) Experimental Design

The experimental format was a 2 x 2 x 4 factorial design, with repeated measures on all three factors. The three factors were, (i) number of elements per stimulus (N), (ii) number of target elements displayed (L), and (iii) context in which the target elements occurred (B), that is, the target letters could be either round or angular, but the background letters were always angular . The background letters were chosen randomly from the set E, L, V, N or I. The round element targets were randomly selected from S, B, O, G or C, while the angular targets were chosen from X, Z, A, K or H. Either one, or three target elements were used. In the three target letter condition,the one different letter was reproduced in three different locations within a display.

On only twenty percent of the trials were all stimulus elements the same. There were 200 trials in total, ten stimuli being randomly presented for each cell of the factorial design.

(b) Subjects

Sixteen psychology undergraduates served as Ss as part of their course requirements.

(c) Apparatus:

A Cambridge single channel tachistoscope was wired to a Lafayette (No. 63020) Reaction Timer, and to three response keys in such a way as to permit mannual control of the illumination within the tachistoscope by S, when the central response key was depressed. The middle key was hence labelled CONTROL, while the keys on either side were labelled SAME and DIFFERENT. For half the Ss the DIFFERENT key was to the right of the CONTROL key. The response keys were 8cm apart, and were operated by the preferred hand of each S.

(d) Stimuli:

Each stimulus consisted of a 20 x 10cm black cardboard card, with a 6.5cm square of white paper (with the typed stimulus elements) superimposed, 9.3cm from the left hand side (LHS) of the black card, and 1.5cm from the bottom of the card, upon it. The prestimulus field was an identical card with a blank white square similarly positioned upon it. Either 10, 20, 30 or 40 elements were placed on the white square, which for this purpose was divided into a 10 x 10 grid of 100 squares into which the letters were randomly assigned using random number tables. The letters were typed, uppercase, using a Standard Olympia typewriter.

(e) Experimental Procedure

The following instructions were given to each S;

"You will see three response keys in front of you. The one labelled CONTROL turns the tachistoscope on and off. I will place a card in the back of the tachistoscope and then say "ready". You may then press the CONTROL key while looking into the tachistoscope, and you will see a number of letters. You are to decide whether or not these letters are all the same, and then you take your finger off the CONTROL key and press the appropriate response key - labelled either SAME or DIFFERENT."

The Ss were then given twelve practice trials and then two hundred experimental trials with a two minute pause after each twenty-five stimulus presentations.

Results:

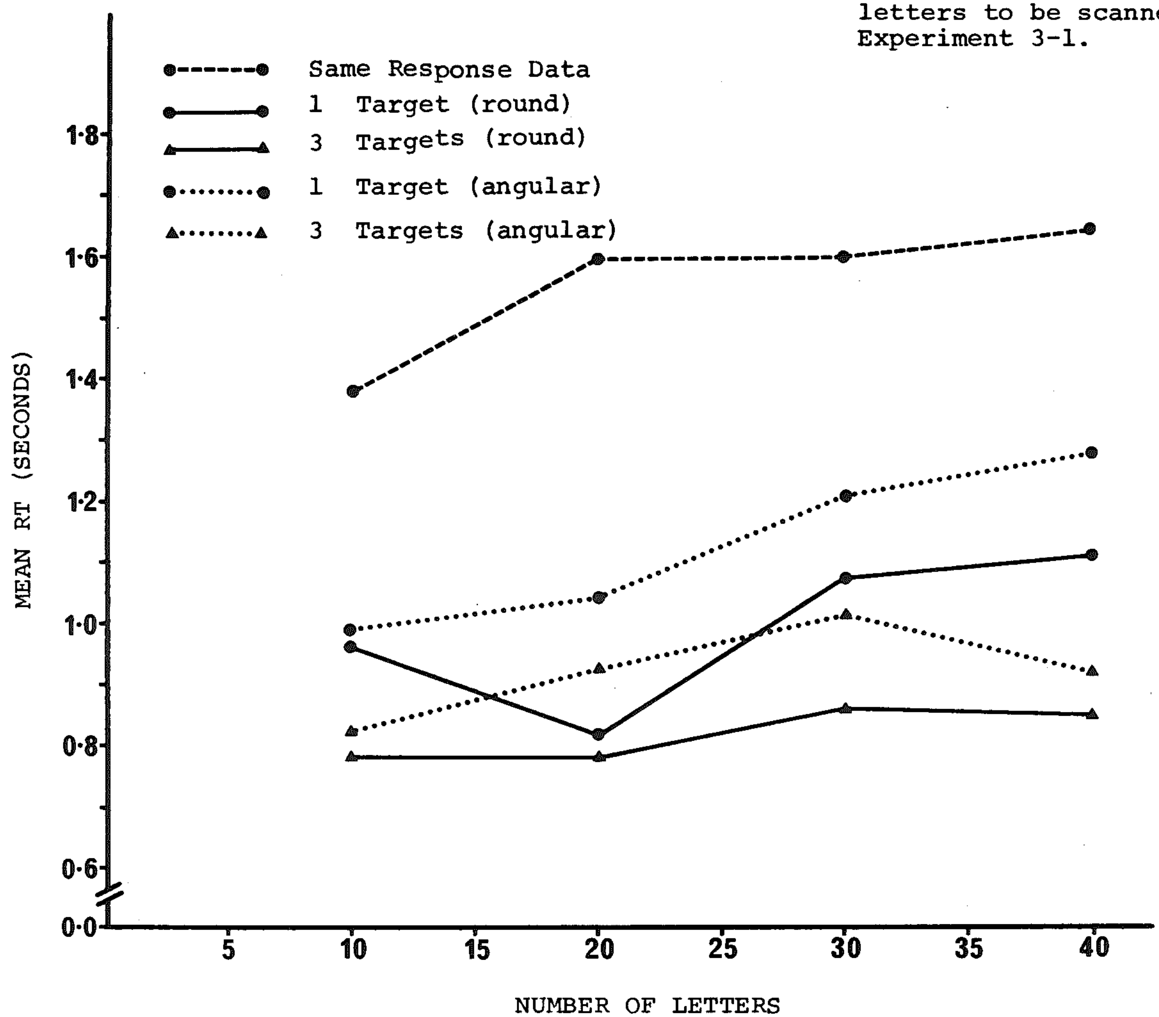
The probability of error, that is, the frequency of errors, expressed as a proportion of total number of trials, pooled over Ss, is presented in Table 3 - 1. The probability of error was generally low, but approached a twenty percent error rate in the one angular target condition.

The mean correct RT data, is presented in

	NO. OF TARGETS	NUMBER OF LETTERS 10	20	30	40
ANGULAR LETTER TARGETS	ONE	.044	.050	.080	.194
	THREE	.006	.025	.044	.019
ROUND LETTER ELEMENTS	ONE	.025	.019	.050	.062
	THREE	.000	.000	.006	.012
SAME RESPONSE	ZERO	.031	.021	.081	.037

TABLE 3-1 PROBABILITY OF ERROR: EXPERIMENT 3-1.

GRAPH 3-1
RT as a function of number of letters to be scanned: Experiment 3-1.



	NO. OF TARGETS		NUMBER OF LETTERS 10	20	30	40
ANGULAR LETTER TARGETS	ONE	MEAN	0.954	1.043	1.200	1.295
		S.D.	0.158	0.245	0.167	0.297
	THREE	MEAN	0.819	0.923	1.011	0.903
		S.D.	0.148	0.164	0.219	0.143
ROUND LETTER TARGETS	ONE	MEAN	0.932	0.824	1.076	1.118
		S.D.	0.177	0.156	0.154	0.232
	THREE	MEAN	0.779	0.769	0.864	0.843
		S.D.	0.14	0.150	0.189	0.185
SAME RESPONSES	ZERO	MEAN	1.371	1.594	1.596	1.653
		S.D.	0.322	0.35	0.519	0.409

TABLE 3-2 MEAN RT AND STANDARD DEVIATIONS

EXPERIMENT 3-1

Table 3-2, and graphically represented in Graph 3-1. Comparison of Table 3-1 and Table 3-2 shows that error probability increased as mean RT increased. The mean RT data was analyzed in two sections, the same response data being separated from the different response data to facilitate interpretation of the results. Since the probability of a same response was not equal to that of a different response, analysis of the results in their entirety would not necessarily have been meaningful.

(a) <u>Same Response Data</u>:

The mean and standard deviations of this data are recorded in Table 3-2, and suggest that the difference in RT between each level of N decreases, as N increases. A one way Analysis of Variance (ANOVA), with repeated measures on factor N, was performed on the mean same RT data of each S. There was a significant N maineffect, indicating that increases in N are associated with a corresponding increase in mean RT ($F = 16.045$, df 3,45, $p < .01$).

The relationship between same RT and number of letters displayed is negatively accelerated (Graph 3-1). The estimated increase in RT, 0.22 seconds, between ten and 20 elements is approximately three times than that between 20 and 40 letters. In fact, 77.68% of the variance in treatment means is due to the difference in RTs between ten and 20 letters.

SOURCE	S.S.	df	M.S.	F	
Between Subj.	7.068	15			
Within Subj.					
No of targets (L)	2.427	1	2.427	279.073	**
Context (B)	0.942	1	0.942	108.280	**
No. of elements (N)	1.541	3	0.514	59.055	**
LB	0.031	1	0.031	3.539	*
LN	0.503	3	0.167	19.276	**
BN	0.159	3	0.053	6.127	**
LBN	0.047	3	0.016	1.801	
Residual Error	1.957	225	0.008		

** $p < .01$

* $p < .05$

TABLE 3-3 ANOVA SUMMARY, DIFFERENT RESPONSE DATA. EXPERIMENT 3-1.

(b) Different Response Data:

The means and standard deviations of these data are presented in Table 3-2. The mean RTs for each S, were treated by a two way ANOVA (Table 3-3) with repeated measures on number of letters (N), number of targets (L), and Context (B). All three main effects were significant ($p < .01$). As is illustrated in Graph 3-1, as N increases mean RT generally increases. Similarly RT tends to increase with a decrease in the number of different target elements. Again, as is shown in the graphical representation, the round letter targets are detected more rapidly in the angular letter background, than the angular targets.

The three two-way interactions were also significant. The LN interaction indicated that the difference in RT due to the number of targets was dependent on the number of letters to be scanned. The scanning rate (Graph 3-2) for stimuli with one target element present was slower than for three targets stimuli. The LB and NB interactions indicated the interdependence of context, and both number of targets and number of elements to be scanned.

Discussion:

This experiment proved to be a successful pilot study for the subsequent experiment with schizophrenic Ss. Error rates were relatively low, and the Ss reported, after the experiment, that the stimulus elements were readily discernable. The study showed that the degree of discrimnability between background and target elements was of extreme importance, and in the later experiment (Chapter 5) only the round target with angular background letters condition was used with the chronic schizophrenics. Different responses were made more rapidly than same responses, although this was confounded with the differential response probability (Table 3-2).

The difference in mean response latencies between one and three targets stimuli is however more substantial, (the overall mean RT to one target stimuli being 1.059 seconds and to the three target stimuli being 0.864 seconds). This result is in accord with predictions made by a model which postulates serial processing at some level. A parallel processing model could also accommodate this finding if it were assumed that the target elements were for some reason (possibly their physical dimensions), processed at a faster rate than the background elements. This seems unlikely in the context of this experiment because of the wide range of target and stimulus elements used. It is also possible that once the elements have been categorized in parallel, the actual response selection and execution can proceed more rapidly with the larger number of different target elements. This explanation is akin to that provided by Bindra et al. (1965), and is used by

Donderi (Donderi and Case, 1970) to explain their very similar data.

The most intrinsically interesting result however was the data from the same mean response latencies. The difference between the mean RTs for the four different levels of stimulus complexity decreased in magnitude as the number of elements to be scanned increased. From Donderi's original results it could be predicted that Ss could handle small quantities of information in parallel but that serial scanning becomes more viable as a processing strategy as the number of stimulus elements increases. A possible explanation may be derived from consideration of Teichner and Krebs' (1974) results. The same response data clearly illustrates the possibility that processing time per item decreases as number of elements increases, up to a limiting RT value. This result is of course tentative. It is not clear how the strong bias towards different responding affects the outcome. Consequently no strong conclusions can be drawn until a second experiment has been performed with equal same and different response probabilities.

Experiment 3-2:

In order to examine in more detail the relationship between same and different RTs, and number of letters displayed, this second pilot study used 20 levels of display size ranging from 3 to 60 letters. Unlike Experiment 3-1, same and different responses were equiprobable:

Method:

(a) Apparatus:

A three channel Scientific Prototype Tachistoscope (Model GB) was wired to a Lafayette Voice Operated Relay in such a way as to allow the initiation of a visual stimulus exposure to be manually controlled, but the termination to be controlled by a vocal response. The stimulus trial sequence was arranged as follows:

(i) Between trials the Ss saw a dark blank field displayed in channel 1.

(ii) When the Ss were ready to commence a scanning trial they pressed a hand operated switch which immediately initiated a white blank prestimulus field (channel 2). This served as a warning foreperiod and lasted for two seconds.

(iii) After two seconds exposure of the warning field, the stimulus field to be scanned was immediately exposed (channel 3). The verbal response "same" or "different" terminated the viewing sequence and the tachistoscopic display returned to the dark field in channel 1.

(iv) The experimenter changed the stimulus card in channel 3, and informed the S that a new experimental trial might commence.

(b) Stimuli

Two hundred stimuli were used, of these half had all letters the same and half had one element changed to make the hundred different stimuli. The background elements used were V, N, L, E or X, and the target different elements were the letters O, G, C, S or B. The stimuli were printed using the Line Printer attached to an IBM 360-44 computer, programmed to randomly order the stimulus elements in a 6.5cm square of white paper. The positioning of the different target element was also randomly determined. The white square was superimposed on a 25.5cm x 18cm black card, 2.5cm from the bottom of the card and 5.5cm from the LHS. The total number of elements ranged from 3 to 60 inclusive, and comprised all the multiples of 3 between those limits. There were five different and five same stimulus cards at each of the 20 levels of stimulus complexity.

(c) Subjects

Twelve first year Psychology undergraduates were used, six of whom were female and six male.

SOURCE	S.S.	df	M.S.	F	
Between Subj.	94.365	11	8.578		
Within Subj.					
No of Letters (N)	29.223	19	1.538	12.924	**
Response (R)	79.898	1	79.898	671.412	**
NR	11.142	19	0.586	4.928	**
Residual Error	51.397	429	0.119		

** $p<.01$

TABLE 3-4

ANOVA SUMMARY TABLE. EXPERIMENT 3-2

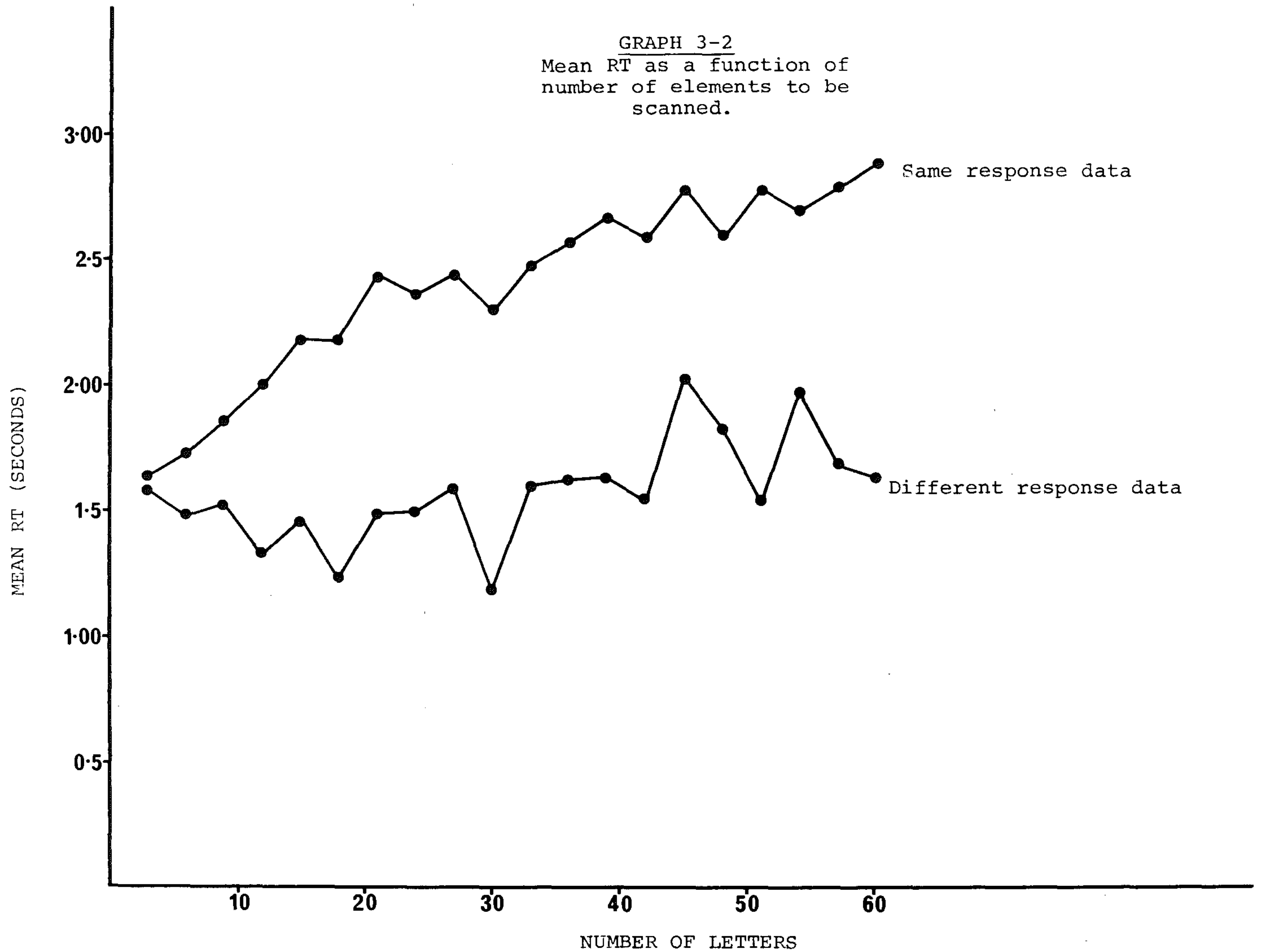
They were paid $NZ1.10 for participating in the experiment.

(d) Experimental Procedure

All Ss were asked to read letters exposed in the tachistoscope of a similar size to those being used in the experiment. This was used as a test of visual acuity and one S was found by this criterion to be unfit for the experiment. The Ss were shown how to operate the apparatus and were then given five practice trials using stimulus cards identical to the stimuli used in the experiment. The sensitivity of the Voice Operated Relay (VOR) was adjusted for each S at this point. The Ss were then given the 200 experimental trials and instructed as with the practice trials, to respond "same" if all letters were identical, and "different" if one letter was different from the background letters. The cards were presented in a different random order for each S, and a one minute rest was given after each 25 trial block.

Results:

The average error per subject was 2.8% For each S, the mean RT of correct responses, for each level of stimulus complexity for both same and different responses, was computed. The mean response latencies, pooled over Ss, are presented in Graph 3-2. The mean data were treated by a two-way ANOVA (Table 3-4) with repeated measures



GRAPH 3-2
Mean RT as a function of number of elements to be scanned.

on both factors, N (Number of letters to be scanned), and R (Response).

The results of the ANOVA confirm the trends apparent in Graph 3-2. As the number of letters increased, RT also increased ($p < .01$). As in Experiment 3-1, the same response curve appears to be negatively accelerated. The same response latencies increased markedly up to the 20 element stimuli, and thereafter, between 20 and 60 elements, the increase was clearly less apparent. There is a strong R main effect also, and RT to same stimuli was greater than to different stimuli. The NR interaction which is also significant ($p < .01$), indicates that the increase due to N was dependent upon R. That is, the scanning rate was faster for different responses than for same responses.

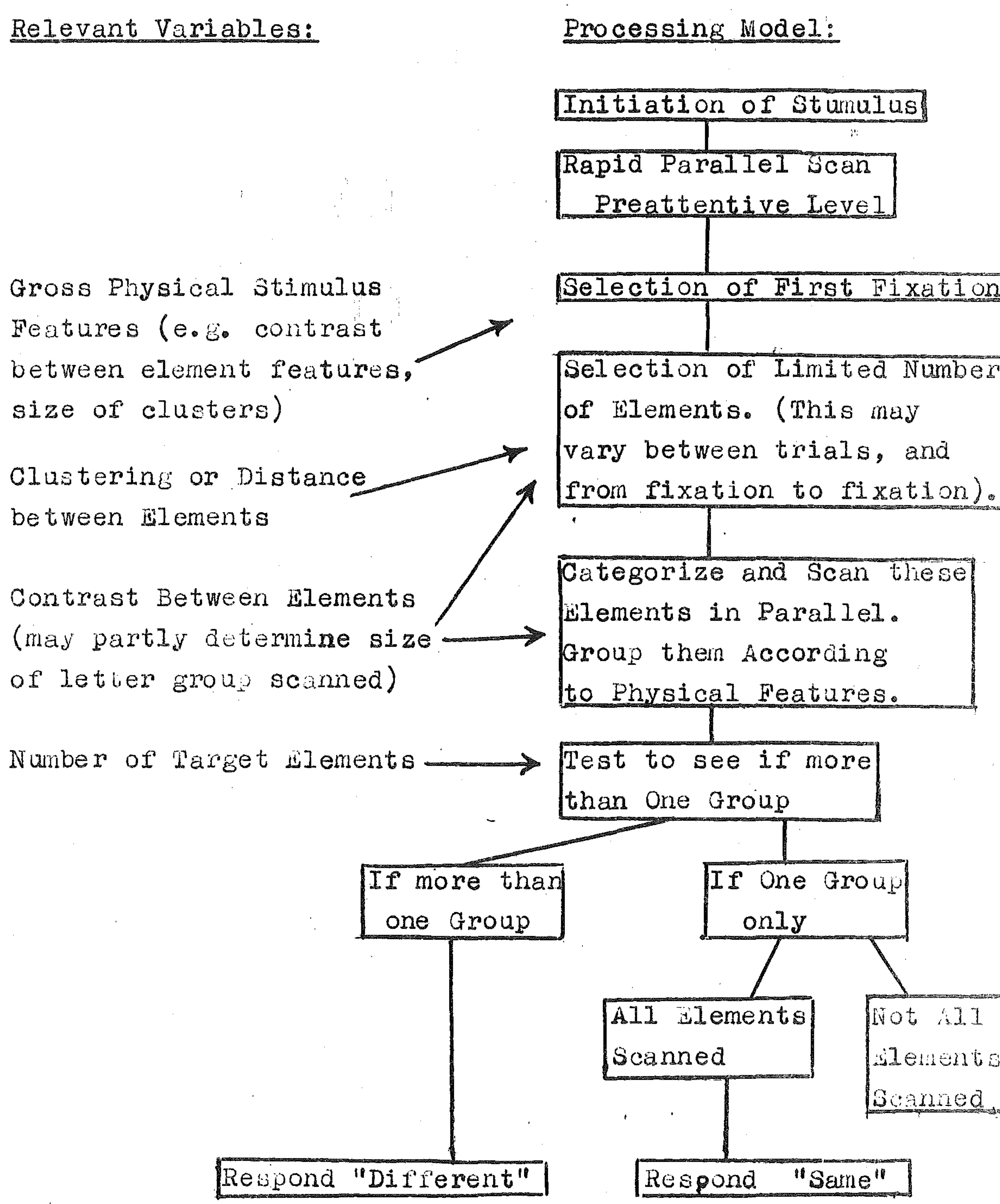
Discussion:

The results of this experiment pose an interesting dilemma and appear to confirm the findings both of Experiment 3-1, and the later results of Chapter 5. The dilemma arises in that the same response curve is negatively accelerated, which implies some support for the view that the strategy of scanning may change when the number of elements exceeds about 20, while the different curve runs approximately parallel to the X-axis, implying a single, possibly parallel, processing strategy. With the same response data, it seems unlikely that a S "selects a strategy" as a precursor to making a scan of the

FIGURE 3-1

HYPOTHETICAL SCANNING STRUCTURE,

EXPERIMENT 3 - 2.



elements, since in order to do so, he would have to scan/count the elements before making a selection decision. Rather than a deliberate decision level being present in the scanning process, it is more feasible that the trial to trial strategy is imposed by the way the construction of the stimulus interacts with a general strategy. That is, rather than there being a deliberate strategy selection procedure there exists one strategy, modified by the configuration or physical nature of the stimulus elements.

The variable most likely to be influential in this respect is the distance between elements. Where the area to be scanned is constant regardless of the number of elements, the total distance between elements, given random placement, is likely to be high with small numbers of elements, and relatively low with larger numbers of elements. In other words, with randomly determined element positioning clusters of elements are more likely to occur with larger numbers of elements. It is possible that parallel scanning can only occur in constricted areas, or is only efficient where a number of elements are grouped together.

This explanation, while plausible for the same response data does not appear to hold for the different response data. The strategy seems different since there is no noticeable increase in RT as a function of the number of elements per stimulus. This may preclude any sequential processing strategy. If Ss were scanning different stimuli in a manner similar to that they employed with the same stimuli, then the different response curve would mimic that for the same response data, but the rate of increase (assuming a self terminating process) would be approximately half as great. The situation portrayed in Graph 3-2 could only arise where the selection of the element, or group of elements, to be scanned first, is biased towards a correct early detection of the target. That is, the first fixation of the stimulus cards is chosen neither at random, nor consistently in the same place. This leads to the consideration of why any one point chosen to commence scanning may be defined by the contrast of round and angular letter features. Ss indeed report that the target letter often "stands out", both in this experiment and in Neisser's (1963) classic study. This may mean that Ss execute a very rapid preliminary parallel scan which ascertains the presence of elements, possibly their numerosity, the area of the largest clustering, and other gross features of the stimulus card as a whole, and this permits selection of a fixation point. This process is similar to Neisser's preattentive scan and may allow the apparent bias towards selecting an area to begin scanning which has a high probability of containing the different element. Hence the same general strategy is used whatever the constitution of the stimulus, but the procedure may be "short circuited" by the selection of an area with high probability of target detection for the initial fixation.

This preliminary scan may only be feasible when there is a high degree of contrast between the background and target elements. Consequently this would accentuate the difference between round and angular letters in Experiment 3-1. It is also possible that Ss choose the largest cluster as the point to commence scanning and that this cluster contains the target on a large enough proportion of the trials to influence the results. A diagramatic model of the type of explanation being advanced for these results is presented in Figure 3-1. The model is essentially a two stage process, with the second stage being hybrid, rather than two stage with second stage containing the possibility of a two strategy - parallel or serial - deliberate choice. This distinction however is of little moment since the idea of a "deliberate choice" versus a "forced choice" is not empirically testable.

This experiment raised some interesting problems and suggested some lines of research which may help in the definition of a model of the processes involved in scanning random elements for binary decisions. Further research in structuring the stimuli - vary cluster size, or the position of the target relative to cluster of elements - could profitably be pursued. This project would be however, beyond the scope of this thesis. What has been established is that this task is sufficiently flexible, and conceptually interesting to use as a measure of scanning rates in normal and schizophrenic Ss. Consequently this task, using the stimuli of Experiment 3-1, was used as Task 5-2, in Chapter 5.

CHAPTER FOUR

SIMULTANEOUS MULTIELEMENT VISUAL COMPARISON

> "It has been said that beauty is in the eye of the beholder. As a hypothesis about localization of function, the statement is not quite right - the brain, and not the eye is surely the most important organ involved. Nevertheless it points clearly enough toward the central problem of cognition. Whether beautiful or ugly or just conveniently at hand, the world of experience is produced by the man who experiences it. (Neisser, 1967; p.3)."

Introduction:

A technique commonly used to measure speed of scanning, for example as a test of clerical speed in the General Aptitude Test Battery is the multielement literal comparison task. Such a measure requires the subject to search for differences in a second letter group after scanning a first group of letters. This type of task differs from that which Sternberg (1966, 1967) has studied, in that both groups to be compared are presented simultaneously and remain to be visually scanned until the subject makes his response. Hence the task emphasizes visual scanning behaviour and possibly lessens the effect of short term memory. With tests of clerical speed which use this basic paradigm, Ss are asked to compare two words for differences, and may be requested to write a response - same or different - as is appropriate. It was decided that this task could be usefully adapted as a measure of visual scanning and selective attention with schizophrenics.

This type of same - different reaction time task has not been investigated systematically in connection with studies of scanning processes. Perhaps the closest parallel to this type of experimentation is provided by the studies of same - different judgements of simultaneously exposed multidimensional geometric stimuli (e.g., Bamber, 1969; Downing, 1971). It was therefore considered necessary to examine the relationships between RT and such variables as word structure and letter length in order to develop a task of sufficient flexibility and theoretical interest for use with chronic schizophrenics.

As will be noted below, both Experiment 4-1 and 4-2 used experimental procedures which were restricted by a lack of adequate apparatus. This was remedied for Experiment 4-3, and Experiments 4-1 and 4-2 should be regarded as primarily preliminary investigations which culminated in the third experiment.

General Outline of the Task:

The following three pilot experiments served to assess the usefulness of the same - different RT comparison task.

In each display, two groups of letters of the following general arrangement where shown to the subject:

	Left Group	Right Group
Same Stimuli	ABCD	ABCD
Different Stimuli	ABCD	AXCD

In all experiments Ss were required to respond "same" when identical letters resided in corresponding locations within each group, and different if one or more letters was different. Letters common to both groups always resided in corresponding locations, and the number of letters (N) in each group, in any one display was always equal, although N varied between displays. The different letter(s) was (were) contained in the left and right groups with equal probability, and the position within a group determined at random. Displays, presented in a Cambridge single channel tachistoscope, were illuminated when the S depressed a key which simultaneously activated the tachistoscope and clock. Both the clock and tachistoscope were turned off when S responded "same" or "different" The subject - determined display exposure duration (RT), was thus recorded.

The letter stimuli in each experiment were typed on a white rectangular area superimposed on a 20 x 10cm black card. The prestimulus field was a same sized black card with a white blank rectangle superimposed on it, identical to those used in the experiment proper. There was no prespecified fixation point placed on the white area.

Although the size of the rectangular area varied within the three experiments reported in this chapter, in each case the distance from the first letter of the first letter group, to the last letter of the second letter group was constant over that experiment. Consequently, while the distance between letter groups varied with the number of letters to be scanned, the total distance over which letter elements, might be placed was constant with respect to number of letters.

EXPERIMENT 4-1

This experiment aimed to show the effect on RT of:

(a) The number of letters (N) within a group letter group sizes of N = 4, 6 or 8 were used.

(b) The mode of organization or structure of letter arrangements within letter groups

Method:

(a) Stimuli

Three major conditions were used to study the effect of letter group structure on RT

(a) Nonwords:

The letter groups used in this condition were chosen at random from the total alphabet using a non replacement technique with all letters equiprobable.

(b) Redundant Nonwords:

In this condition each letter group, which comprised randomly selected letters, contained three letters repeated, e.g.,

	Left Group	Right Group
Same Stimulus	FFFGB	FFFGB
Different Stimulus	LKLBL	LHLBL

The different letter was chosen at random, and could be one of the repeated letters.

(c) Words

The words were chosen from the thousand most frequently used words, as categorized by Wright (1966).

The experimental design was a 2 x 3 x 3 factorial design with repeated measures on all three factors. The three factors were, (a) Response, same or different, (R), (b) Stimulus structure (W), and (c) Number of letters, N. The levels of N were equiprobable, and there were a total of 180 cards. The white rectangular area (7.6 x 2.5cm) was superimposed on the black card 8.3cm along and 3.5cm up from the bottom left corner. The letters were typed using an Olympia Typewriter (Standard Model, 1969) in uppercase, with the constant distance from the first to last letter being 4.6cm.

The letter groups were horizontally arranged, 1.5cm along and 1cm from the bottom left hand corner of the white rectangle.

(b) Apparatus:

The tachistoscope was connected to two hand response keys such that one key initiated the tachistoscopic display and a Lafayette clocktimer, while the second key was used as a response key, and stopped the clock. The tachistoscope remained in operation for as long as the S held his finger on the control key.

(c) Procedure:

The Ss were given typewritten instructions which explained the "control" key which turned the tachistoscope on, and controlled the length of stimulus exposure, and the "response" key which stopped the timing device as soon as it was depressed. The Ss were told to call out at the same time as they pressed the response key either "same" if the letter groups were identical or "different" if one of the letters had been changed. The response from S was organized in this way since it had been found in Experiment 3-1 that some Ss had considerable difficulty in remembering which of the two keys labelled either same or different to press, and this contributed to the variance of scanning rates. This solution however was not necessarily optimal and it was with the introduction of the Voice Operated Relay in Experiment 4-3 that a more suitable response mechanism was developed. Subjects were told to respond as quickly and as accurately as possible and were shown three stimulus cards to illustrate the experimental procedure.

Eight practice trials were given with separate stimuli, similar to those used in the main experiment. A three to four minute rest was permitted after 90 cards had been administered. Total testing time varied between 35 and 45 minutes.

(d) <u>Subjects:</u>

Fourteen undergraduate psychology students were used as Ss, and served as part of their course requirements.

<u>Results:</u>

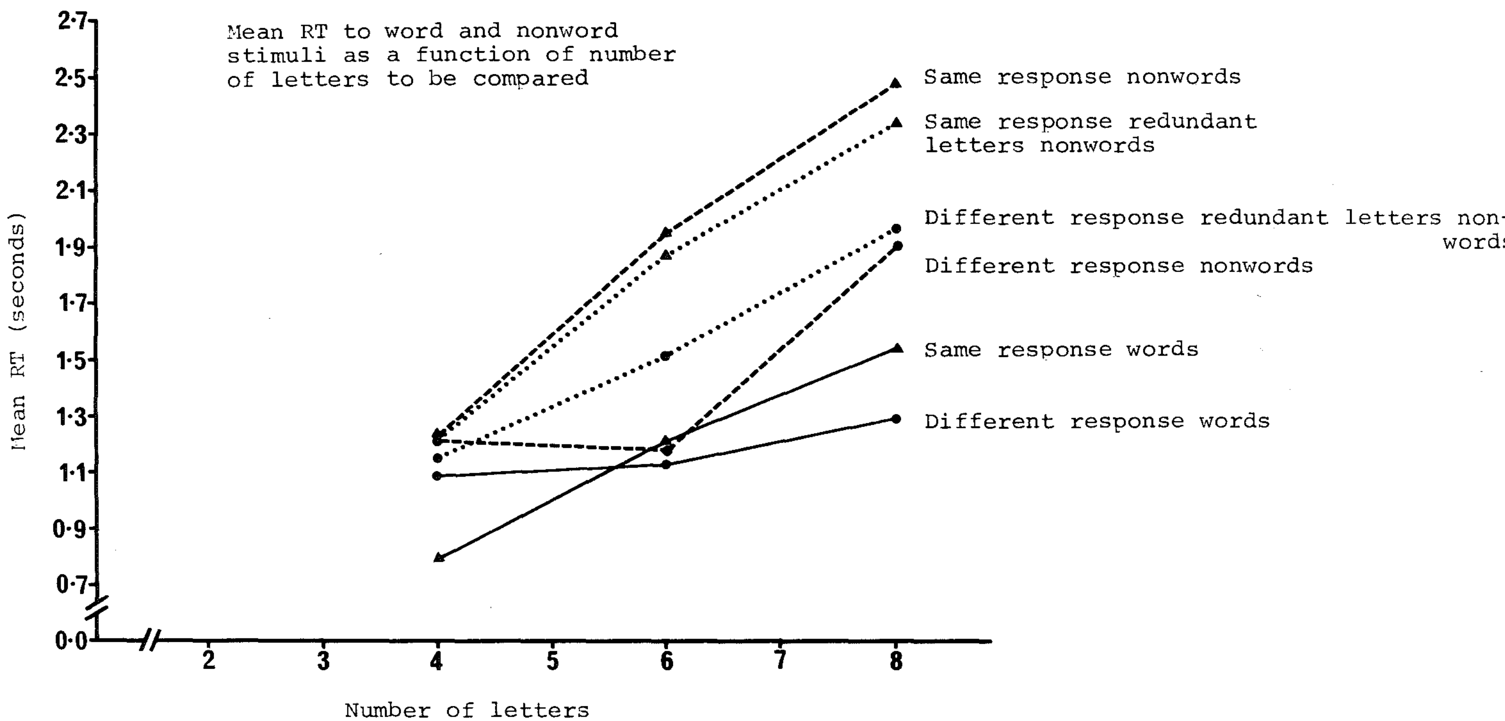
A three factor ANOVA with repeated measures on all factors was performed on the mean correct RT scores of all Ss. The results of this analysis are presented as Table 4-1.

As is illustrated in Graph 4-1, mean RT was influenced by stimulus structure. The ANOVA confirmed this effect, and there was a significant difference ($p < .01$) on W, with RT to words being faster than to either nonword condition. The difference between mean RT to nonwords and redundant nonwords was slight, especially for the same response data. The significant WR interaction demonstrated that differences in scanning rate due to response, varied with the stimulus structure conditions. This is evident in Graph 4-1, where the scanning rate for both conditions of nonwords was similar and slow, for both same and different responses. In the word condition however, the scanning rate for same responses is slow, and parallel to the rates for nonwords, while scanning rate for different words is much faster.

Different responses were made more rapidly than same responses ($p < .01$). The significant RN interaction ($p < .01$) is evidence that scanning rates were different between response conditions, and

GRAPH 4-1
Experiment 4-1

Mean RT to word and nonword stimuli as a function of number of letters to be compared



SOURCE	S.S.	df	M.S.	F	
Between Subj.		13			
Within Subj.					
Stimulus Structure (W)	13.570	2	6.785	81.42	* *
Response (R)	2.770	1	2.770	33.26	* *
No. of Letters (N)	23.762	2	11.881	142.67	* *
RW	0.709	2	0.354	4.26	* *
RN	1.632	2	0.816	9.80	* *
WN	3.013	4	0.752	9.05	* *
RWN	0.175	4	0.044	0.52	
Residual Error	18.409	221	0.083		

* * $p < .01$

TABLE 4-1

ANOVA SUMMARY TABLE

EXPERIMENT 4-1

Graph 4-1 shows that the scanning rate for different responses was less than for same responses. This provides some support for a self terminating process in the comparison procedure.

The ANOVA also revealed that as N increased, so did mean RT ($p < .01$). It is clear however, both from the graphical presentation, and the significant WN interaction ($p < .01$) that the rate of increase depends on stimulus structure. Increase due to N is less for word stimuli than for either of the nonword stimulus conditions.

Finally, the task produced relatively low error rates, for normal Ss. The mean probability of error was approximately equal to .03. The Ss reported however that the task was demanding, and a far higher error rate might be expected from schizophrenic Ss.

Summary and Conclusions:

This preliminary study established that multielement visual comparison could be investigated using tachistoscopic presentations of horizontally arranged literal stimuli. Increases in redundancy due to imposing word structure on the letter stimulus elements lowered RT when compared with the nonword conditions. Different responses were made more rapidly than same responses, which is in accord with a self terminating search strategy. This difference was most pronounced with the word stimuli. Increases in N led to increases in mean RT, and this increase appeared, by visual inspection, to have a large linear component. Increases in RT due to N were least for the word condition.

For schizophrenic Ss however it was felt that this experiment, in conjunction with other tasks, was rather lengthy, and that the large values of N would produce too great an error rate for meaningful between group comparison. Experiment 4-2 was undertaken therefore to explore methods of task load reduction.

EXPERIMENT 4-2

In order to reduce task difficulty several modifications were undertaken. The number of letters to be scanned was decreased, and the number of different letters was increased from one to two. The size of the experiment was reduced by eliminating the redundant nonword condition, which had not produced results differing greatly from the nonword condition, in the previous experiment.

Method:

(a) Stimuli and Experimental Design:

The experimental format was similar to that of Experiment 4-1, being a 3 x 2 x 2 factorial design with repeated measures on all factors. Factor N, number of elements to be compared had three equiprobable levels - either 4, 5 or 6 letters were used. Factor R, the response, was either same or different, and Factor W had two levels, either word or nonword stimuli.

The stimuli were constructed in exactly the same way as they were in the preceding experiment. The dimensions of the stimulus card, and the size and position of the white rectangular area were unchanged. The typed letters were arranged over a constant 4.6cm from the first to last letter. The word stimuli were chosen from the 500 most commonly used words in the Lorge - Thorndike word list. The only difference in the stimulus construction between Experiments 4 - 1 and 4 - 2 was that the second study had <u>two</u> letters, chosen at random, replaced by randomly determined letter elements, not already present in the word or nonword letter sequence.

(b) <u>Subjects</u>

Fourteen first year psychology students completed the experiment as part of their course requirements.

(c) <u>Procedure</u>

The apparatus used in this experiment was identical to that used in Experiment 4 - 1.

Ss were given a set of typewritten instructions and the nature of the same and different stimuli was explained and examples given. Ss were informed that -

"...your task is to decide which stimuli are the same and which are different.

When you have decided, take your finger off the Control key and press the one labelled Response. <u>At the same time</u> I also want you to call out either "same" or "different", so I will know what you have seen."

The experimental procedure was also similar to that of the previous experiment, and eight practice trials were given prior to the presentation of the stimulus cards.

There were a total of 120 stimulus cards, there being ten cards for each level of each condition.

A two minute rest was given after each 40 experimental trials.

Results:

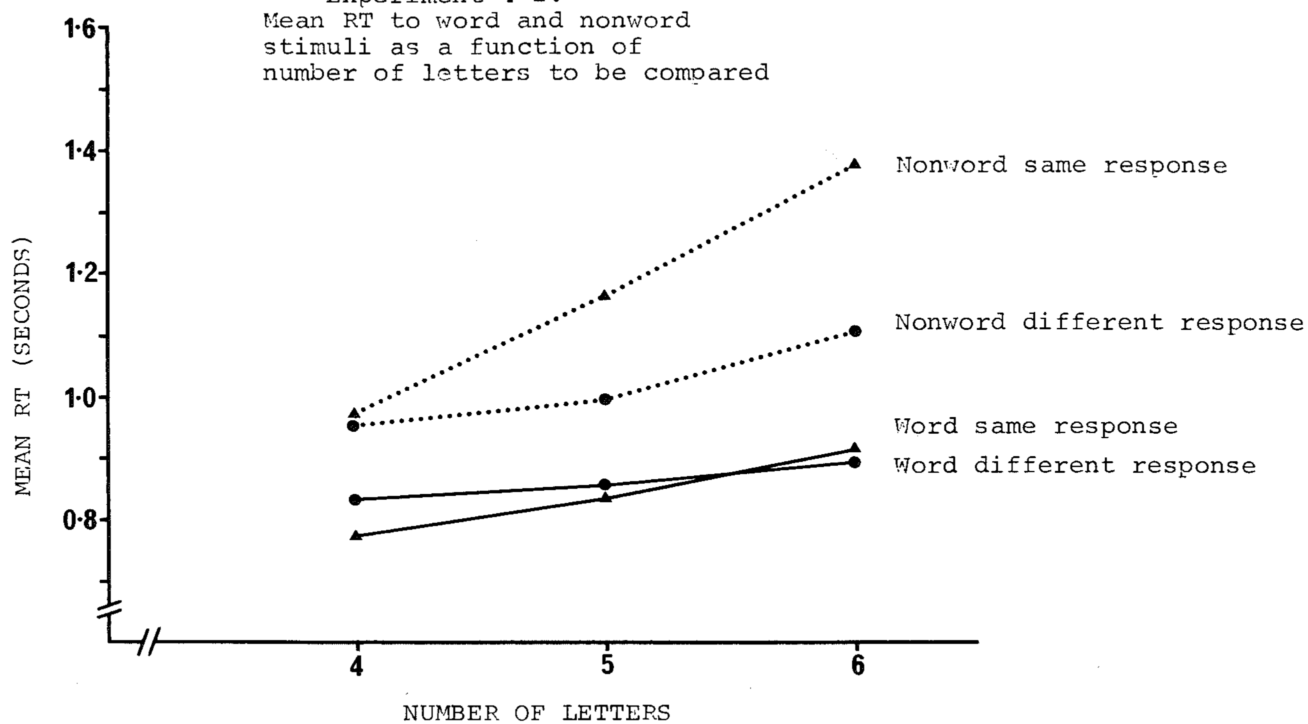
The probability of error in this experiment was reduced to approximately .01. Generally, RT was considerably decreased, as can be seen by comparing Graphes 4-1 and 4-2.

A 3 factor ANOVA with repeated measures on all factors was performed on the correct mean response data of all Ss. Stimulus structure was found again to be an important variable and response latencies to nonwords were greater than to words ($p < .05$). The nonsignificant WN interaction indicated however that scanning rates for words and nonwords were similar.

As illustrated in Graph 4-2, there was a clear difference between same and different responses, especially for nonwords, with same responses being completed more rapidly ($p < .01$). The significant WR interaction indicated that same response latencies were slower only for nonwords ($p < .01$).

As in the previous experiment N was significant, and mean response latency increased as number of elements to be scanned increased ($p < .01$). The significance of the RN interaction ($p < .01$) showed however that the effect of N is greater for same responses than for different responses.

GRAPH 4-2
Experiment 4-2:
Mean RT to word and nonword stimuli as a function of number of letters to be compared



Source	S.S.	df	M.S.	F	
Between Subj.	9.407	13	0.723		
Within Subj.					
Stimulus Structure (W)	0.119	1	0.119	4.519	*
Response (R)	2.828	1	2.828	106.967	**
Number Letters (N)	1.145	2	0.573	21.659	**
WR	0.262	1	0.262	9.905	**
WN	0.131	2	0.065	2.470	
RN	0.306	2	0.153	5.793	**
WRN	0.033	2	0.017	0.627	
Residual Error	3.780	143	0.026		

TABLE 4-2

ANOVA SUMMARY TABLE

EXPERIMENT 4-2

Conclusions and Summary:

The primary aim of this experiment was to determine whether RTs could be lowered by using greater differences in the different stimuli, and this proved possible. Comparison of the Graphs 4-1 and 4-2 showed clearly that response latencies in this experiment were less than in Experiment 4-1.

As in Experiment 4-1, letter group structure, type of response, and number of letters to be scanned influenced response latencies. Error rates were also lower in this study than in Experiment 4-1.

This type of study, using two different letters, did result in some loss of information, since serial position effects can not be investigated. Consequently it becomes considerably more difficult to attach meaning to such terms as "self terminating", "exhaustive", "serial", and "parallel" when more than one letter is altered to contrive a different stimulus. For this reason, only single letter changes were used in the later experiment with schizophrenics.

EXPERIMENT 4-3

The final study was carried out primarily to establish the results of the preceding studies using a voice activated timing mechanism, to measure response latencies. In part however, Experiment 4-3 was undertaken to determine the effect increasing the number of different letters has on RT. Comparison of Experiments 4-1, and 4-2 showed that not only the different RTs but also the same RTs were decreased when two, rather than one, altered letters were used to construct the different stimuli. This suggested that Ss may scan same stimuli more rapidly, or less completely, when the degree of difference in the different stimuli is increased.

However, there were differences between the two experiments, notably in the total number of stimulus cards, and in the values of N used, which could have produced these results. For this reason the previous two studies were repeated under comparable conditions, using the modified and more satisfactory apparatus.

Method:

(a) Experimental Design and Stimuli

The experimental format was a 2 x 3 x 2 x 2 factorial design with repeated measures on the final three factors (Winer, 1962). The first factor was Groups (G), and the first group of Ss

(G1) differed from the second (G2) in that the different letter stimuli which they saw contained only one letter changed, while the different stimuli for Gs had two letters different (as in Experiment 4 - 1). The three repeated factors were N, R, and W, defined as in Experiment 4 - 2. The values of N used were 3, 5 or 7 letters, and there were a total of 120 stimuli in all.

The word and nonword stimuli were constructed as in the previous experiment, with some minor modifications. The white rectangular area on the black card was reduced in size (6cm x 1.1cm) and was located 8cm along and 4.5cm up from the bottom left corner of the card. The stimuli were typed in uppercase on an IBM Selectric Typewriter such that the distance from first to last letter was a constant 4cm. The horizontally arranged stimulus letters were located 1cm along and 0.3cm up from the bottom corner of the white rectangle.

(b) <u>Subjects</u>

Two groups of 14 Ss were recruited from amongst first year Psychology undergraduates, half of each group were male, and half female. Ss were unpaid and served as part of their course requirements.

(c) <u>Apparatus</u>

The tachistoscope was wired to a voice operated relay (Lafayette VOR: Model 604A) such that when the subject manually initiated the tachistoscope, he simultaneously activated a Lafayette digit counter-clock (Model 54417) which was turned off together with the tachistoscope when the S made a verbal response. Both clock and tachistoscopic picture stayed on until such time as the subject made a verbal response.

(d) Procedure

The apparatus and procedure were explained to the Ss by means of a set of typed instructions. They were told -

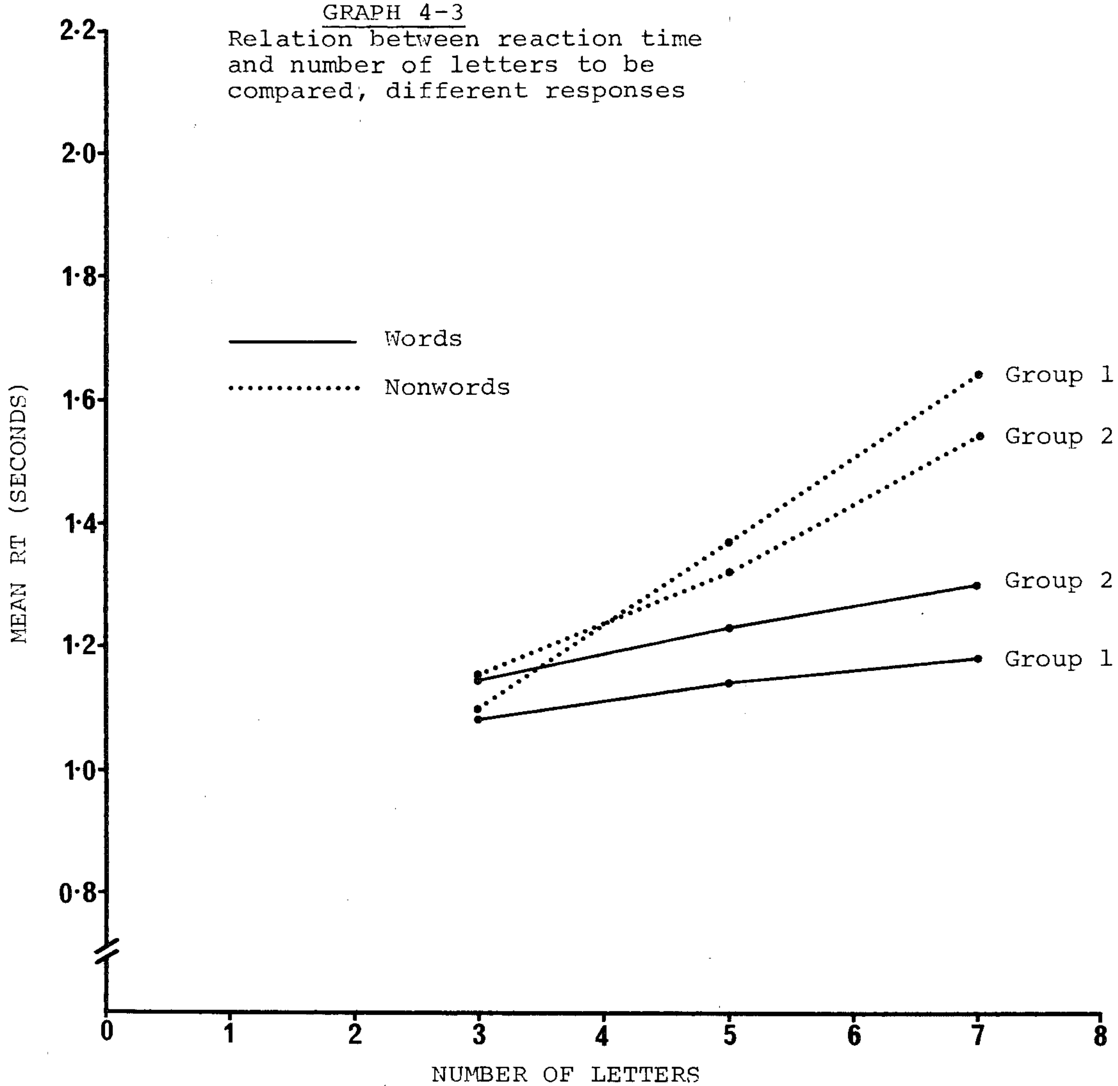
"Your task is to look at the cards as I put them in the back of the tachistoscope and tell me whether or not the group of letters on the one side is the same as that on the other side."

Subjects from G1 were then shown some examples and told to -

"note that the different letter groups have only one letter changed."

G2 received similar examples and instructions but were told that two letters were altered. Otherwise instructions were the same for all Ss. Five practice trials with cards similar to those used in the main experiment were administered to familiarize

GRAPH 4-3
Relation between reaction time and number of letters to be compared, different responses



Ss with the apparatus, and then 120 stimulus cards were presented in a different random order for each S. The experiment took about 25 minutes and was followed by a brief post experimental questionnaire, and Ss were asked about the experiment and the way in which they thought they had scanned the stimuli.

Results:

The probability of error was similar for both G1 and G2, and the mean probability was 0.025 over the whole experiment. The mean correct RT data for all Ss was divided into same response, and different response data, to facilitate interpretation of the results. The mean same response data for both groups is presented as Graph 4-3, and the different data as Graph 4-4.

(a) Same Response Data:

A 2 x 3 x 2 ANOVA, with repeated measures on the final two factors, N and W, was performed on the mean correct same response data of all Ss. As can be seen in Graph 4-3, there was no apparent difference between groups, and this was confirmed by the nonsignificant G main effect (Table 4-3). Also the trend for RT to increase as number of letters to be compared increased, was significant ($p < .01$). The WN interaction was also significant ($p < .01$), indicating that the

SOURCE	S.S.	df	M.S.	F	
Between Subj.					
Groups (G)	0.003	1	0.003	0.009	
Subj. W. Groups	6.946	26	0.267		
Within Subj.					
Stimulus Structure (W)	7.786	1	7.786	96.860	**
WG	0.023	1	0.023	0.288	
W x Subj. w. Groups	2.090	26	0.080		
Number of Letters	11.070	2	5.535	63.374	**
NG	0.013	2	0.007	0.077	
N x Subj. w. Groups	4.542	52	0.087		
WN	2.924	2	1.462	44.141	**
WNG	0.074	2	0.037	1.111	
WN x Subj. w. Groups	1.722	52	0.033		

** $p < .01$

Table 4-3

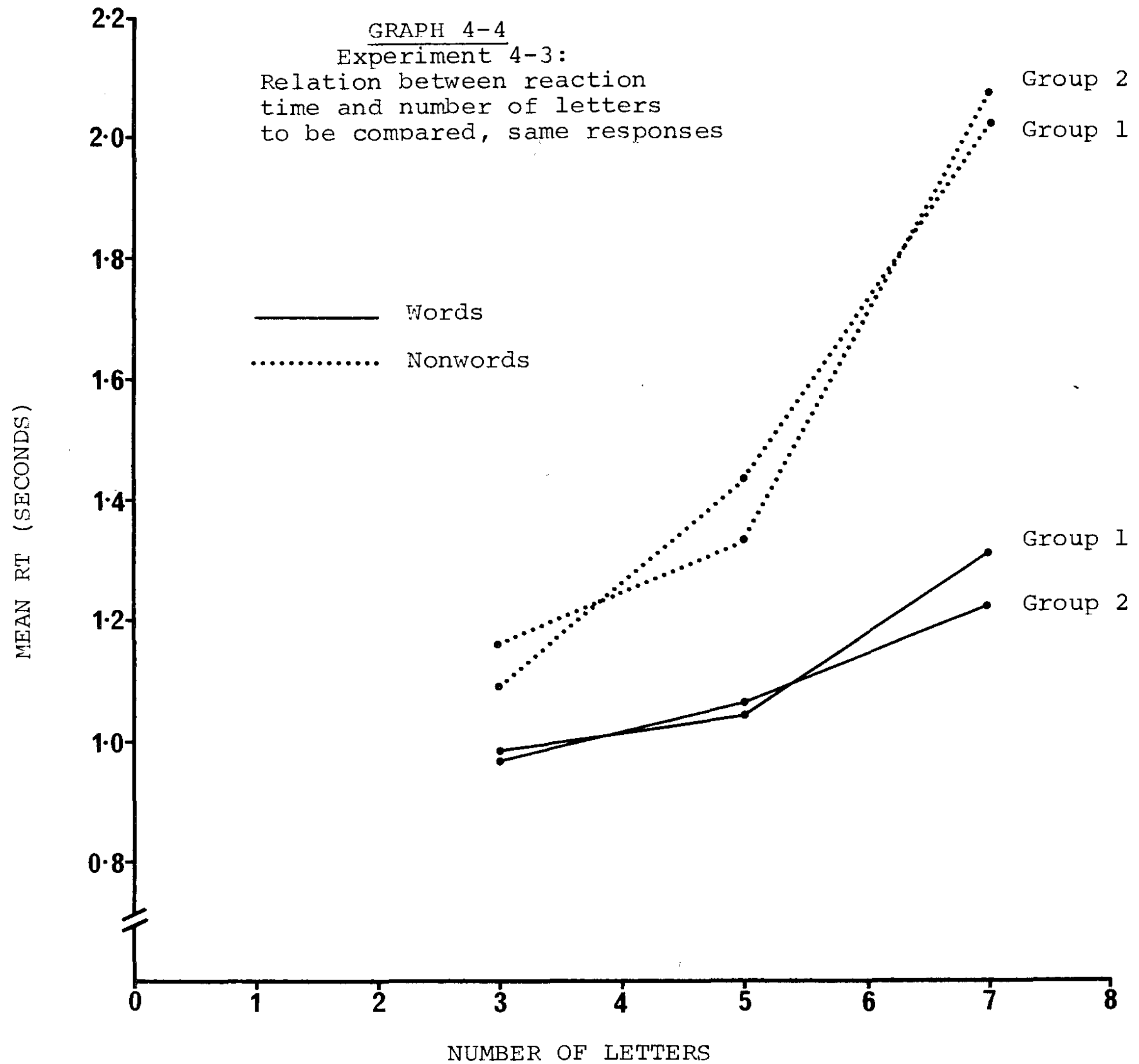
ANOVA SUMMARY TABLE, SAME RESPONSE DATA. EXPERIMENT 4-3.

rate of increase in RT with increases in N is greater for nonwords, than for words. It can be inferred from this that scanning rates for same responses to words are more rapid than for nonwords.

(b) <u>Different Response Data</u>:

The mean different responses are illustrated in Graph 4-4, and a summary of the 3-factor ANOVA is presented as Table 4-4. Again the lack of difference between groups is apparent. Even although the difference between groups of letters to be compared increased for G2, response latencies have not altered. RTs to nonwords are significantly greater when N is larger ($p < .01$). The significant WN interaction is the product of more rapid scanning rates for words than for nonwords ($p < .01$).

The significant WG interaction is the product of the fact, illustrated in Graph 4-4, that the mean response latencies for each group differs for the two different levels of W. More time was taken by G2 than G1 in responding to different words, while G1 had the longer response latencies for the nonword levels. Since this interaction might well have obscured a simple G main effect, especially with the word stimuli (Graph 4-4). An a posteriori test (Tukey's q-ratio) was performed on the mean difference between G1 and G2 at the word stimulus level. This difference was not statistically significant ($q = 2.72$, $p < .05$).



GRAPH 4-4
Experiment 4-3:
Relation between reaction time and number of letters to be compared, same responses

SOURCE	SS	df	MS	F	
<u>Between Subj.</u>					
Groups (G)	0.036	1	0.036	0.410	
Ss within groups	2.314	26	0.089		
<u>Within Subj.</u>					
Letters structure (W)	1.293	1	1.293	124.125	**
WG	0.172	1	0.172	16.505	**
W x Subj. w. groups	0.260	26	0.010		
Number of letters (N)	2.580	2	1.290	55.522	**
NG	0.014	2	0.007	0.313	
N x Subj. w. groups	1.196	52	0.023		
WN	0.782	2	0.391	23.844	**
WNG	0.068	2	0.034	2.069	
WN x Subj. w. groups	0.032	52	0.016		

** $p < .01$

<u>TABLE 4-4</u> <u>ANOVA SUMMARY TABLE, DIFFERENT RESPONSE DATA EXPERIMENT 4-3</u>

(c) Serial Position Effects:

An investigation of serial position effects was also attempted and the results are presented as Table 4-5. These results are for G1 only since with two letters altered, serial position effects became meaningless. Table 4-5 also shows the effects of the changed letter for the word stimuli, within the first or second letter group. The results require cautious interpretation however, since it is apparent that it is impossible to have equal numbers of stimuli in each condition - i.e., with the seven letter stimuli, and ten stimulus cards in each condition, some of the serial positions of changed cards will have two stimulus cards, while most will have only one. Only with the five letter stimuli was it possible for each serial position to be used with equal frequency as the altered letter position.

The results of this investigation are not particularly clear. Whether the altered letter is in the first or second word, appears to be unimportant. Further, with word stimuli, altering the first three letter elements, did not produce any great difference in RT, but response latencies tended to steadily increase as the serial position became further from the LHS of the word. With nonwords, the data is more confused, however it appears as if RT increases, as serial position tends to the right, but the last and first letter is more readily perceived as altered than the central

Stimulus Structure	Three		Five		Seven	
	Word	Nonword	Word	Nonword	Word	Nonword
Serial Position						
ONE	1.052	1.084	1.062	1.274	1.117	1.380
TWO	1.057	1.114	1.120	1.300	1.125	1.657
THREE	1.113	1.129	1.024	1.439	1.070	1.794
FOUR			1.229	1.523	1.254	1.591
FIVE			1.227	1.174	1.362	
SIX					1.109	1.910
SEVEN					1.406	1.833
Position of Word Changed						
FIRST	RT=	1.084	RT=	1.109	RT=	1.188
SECOND	RT=	1.080	RT=	1.157	RT=	1.195

Table 4-5

MEAN RT (SECONDS) AS A FUNCTION OF SERIAL POSITION

NUMBER OF LETTERS.

letters, in the five and seven letter groups. When only three letters are to be scanned, serial position is of minimal importance.

(d) Questionnaire:

A post experimental questionnaire was also given to formalize questioning about fatigue during the experiment, and to determine the strategies of scanning Ss reported using. Generally Ss did find the experiment tiring, but were equally divided as to whether they improved as the task progressed. Subjects reported using a number of strategies when scanning nonwords, and the tendency was to report using a combination of strategies. With word stimuli 71% of the Ss reported using a strategy which involved comparison of whole words. Most of the Ss reported that they terminated search when the different letter was found. No consistent difference in reported scanning strategy between groups was apparent. While the limitations of such a questionnaire are readily obvious, it served to illustrate the possibility that the strategy Ss use may well vary from trial to trial, and that wide individual differences occur.

Summary and Conclusions:

The results of Experiment 4-3 were interesting in that the expected difference between groups did not eventuate. Indeed the results were paradoxical, since increasing the degree of difference did not lower reaction time, whereas the slope of the different responses was clearly less than that for the same responses. It seems unlikely that processing was purely serial, and the differences due to type of response made seems to rule out parallel processing of an unmixed variety.

Combining Graphs 4-3, and 4-4 however, the picture here becomes slightly clearer, and the possibility of a mixed serial-parallel model might be advanced. With nonword stimuli same and different responses for three and five letters are very similar whereas they differ markedly at the seven letter level. Both G1 and G2 results are very similar. This strongly suggests that Ss are able to process a limited number of comparison letters in parallel - probably about four or five. If there are more than five letters however, a second parallel comparison must be made, and this is in series to the first comparison. The reason for the lack of difference between G1 and G2 may be that whether one or more letters have been altered, can make little difference to a parallel scan (as opposed to a strictly serial scan where letter position determines RT if scanning is carried out in a strictly ordinal fashion). Since in both conditions the changed letter is most likely to occur in the first five letters (with seven letters the probability for G1 is 0.71 and for G2 it would be 0.95), and with the small number of stimuli involved, this difference in probability is unlikely to be of much importance. A similar interpretation might be placed on the results for words, except it seems clear that the capacity is not limited to approximately five as it is with nonwords. Some further evidence to support this hypothesis is provided by the serial position effect data, where it can be seen that RT for letters changed in position six and seven are greater than for the preceding five positions.

The above conclusions however need much more empirical investigation and are presented only as tentative explanations to be further substantiated or rejected. Several factors indicate considerable care should be taken in reaching firm conclusions.

(a) The manner in which a different experimental structure, apparatus, and means of making a response rendered hypotheses generated by Experiments 4-1, 4-2, invalid in Experiment 4-3. The dependence of RT on experiment specific factors makes generalization from one scanning experiment to another very hazardous.

(b) If indeed some limited capacity model is tenable, then it is unlikely that the capacity is the same for each subject, or even constant from trial to trial. If, as has been commonly shown, scanning rates depend on practice, then it seems reasonable that different Ss may enter the situation with different abilities which will confound further any rigid generalization.

(c) Different Ss, as they indicated on the questionnaire, felt they varied strategies from trial to trial. If they did not do this consistently then data from individual Ss would have to be fitted to some type of random walk model (Laming, 1968), and certainly data pooled over Ss would be meaningless.

The overall purpose of these experiments was to give some idea of the gross features of this visual comparison paradigm. Further detailed experimentation along the lines suggested by Townsend (1972) would be necessary to build an adequate mathematical or cognitive model to describe completely the way in which such comparisons are made. It was felt that for the purposes of experimentation chronic schizophrenics, a sufficient knowledge of the processes involved in multielement visual comparison of literal stimuli has been achieved.

CHAPTER FIVE

THE SCANNING AND SEARCH BEHAVIOUR OF SCHIZOPHRENIC SUBJECTS - EXPERIMENT 1.

> "The effects of untestability are two fold. On the one hand, the possibility of curvilinear relationships or systematic bias reduces severely the range of generalization permissible when Psychological tests are the sole criterion in a research. On the other hand, it is possible that the failure of many psychological tests to differentiate groups as expected on theoretical grounds lies not with an incorrect hypothesis, but with a segment of the population, vital to the hypothesis, being untestable (Ullman, 1961, p.201).

Introduction: Aims of the Experiment

The purpose of the experimental tasks to be detailed below was to explore, in terms of the theoretical developments reviewed in Chapter 2, the nature of the postulated attentional deficit in schizophrenia, by means of visual scanning tasks.

Results of work at the Menninger Foundation (Silverman, 1972; Cromwell, 1972) have suggested that the rate of gain of information in schizophrenic Ss may be impaired:

> "Sensory data do not reach awareness in schizophrenics in the same form, to the same extent, and with the same subjective intensity as they do in nonschizophrenic individuals. In some phases of the illness and in some forms of schizophrenia the attention gates are open too wide; selective

> functions have broken down; too much information for orderly processing is permitted to enter information processing channels. During other phases of the illness, and in other subgroups, inhibiting functions are too hyperactive, the gates are shut too tight, and only a narrow span of information enters the system (Spohn, Thetford and Cranco, 1970, p.259-260)."

The conclusions upon which this formulation is based have been derived from size constancy and size estimation experimentation, which often produces very tenuous results (Cromwell, 1972; Neale, 1971; Neale et al. 1969). More flexible methodologies yielding more detailed results and allowing greater manipulation of informational input have been sought.

The background to this experiment has provided by the survey of literature in Chapter 2. There is therefore no necessity to provide an overview of the findings of these studies as an introduction, but it remains essential to place the research to be presented into the context of the profusion of studies dealing with cognitive deficit in schizophrenia. It becomes evident from any such literature review however, that as far as any theoretical description of schizophrenic deficit can beprovided, most researchers have produced as they themselves may acknowledge, very similar formulations. Such contrasts between theories as are stated arise largely from the utilization of differing performance tasks, by the various theorists. It is possible to summarize much of the research with information processing tasks by claiming that it has been generally shown that psychotics have slow and variable RTs in relation to normal control Ss, and tend to make more errors, especially on conceptual tasks. This leads to the question - why is this so? The principal reason why the answers provided to this query have been unsatisfactory has often been a reluctance to conceptualize schizophrenic performance in terms of an information processing notion of task demand characteristics. The recent work of Neale and his colleagues described in Chapter 2 (Neale, 1971) and that of Yates (e.g., Korboot and Yates, 1973) have demonstrated an increasing concern for this potentially more illustrative approach to such research. These studies are also a testament to the greater acknowledgement of the relevance of investigations reported in cognitive psychology. While the understanding of the cognitive processes of normal Ss is incomplete, cross-fertilization of ideas from these areas of endeavour is becoming increasingly significant.

While the tasks reported in this first experiment have a wide basis in their essential task demand characteristics, they can also be seen as representing a rather limited focus. The present study is concerned with the visual scanning of multielement stimulus items of varying complexity, and with the general ability of schizophrenics to locate relevant information and to discard the irrelevant input. Relevancy is a concept often implicit in this field, particularly in relation to work on distraction, which is seldom clearly defined. In some experiments of selective listening with schizophrenics, the relevant stimulation is that to which the S, is required to respond (as in Broadbent's, 1958, and Treisman's 1969, paradigms). Schizophrenics appear to perform less adequately under conditions in which there is competing input (Lawson, Chapman and McGhie, 1967; Payne, Hochberg and Hawks, 1970) either because they allow (or are unable to avoid) processing of some elements to pass beyond the stages required for identification of those elements as redundant, or because it takes longer for psychotic Ss to make the necessary tests on each irrelevant item. The visual analogue behaviour, where the S is instructed to select that information relevant to the desired response requirements. In each task reported below however, the response demands are held constant over that task, and it is the nature and quantity of the elements to be scanned, which comprise a total stimulus complexity, which is varied. The focus is narrow therefore, in that a very limited sample of schizophrenic and normal behaviour has been chosen; the approach is broad however, in that this behaviour is measured in a variety of tasks, with a largely exploratory emphasis appropriate to the limited knowledge of the nature of the postulated deficit in this context.

Accordingly, three groups of Ss, nonparanoid and paranoid process schizophrenics, and non hospitalized, non psychiatric controls were selected. These three groups were matched for age, education, vocabulary score, and occupation, and the schizophrenic groups were matched on chronicity measures and length of hospitalization as well. It was proposed also to investigate the correlation between these subject variables, and measures of task performance.

Selection of Subjects;

(a) Schizophrenic Subjects:

The sample tested was drawn from five long stay and four admission wards at Sunnyside Hospital, Christchurch, New Zealand, during December 1972, and January and February, 1973. Since paranoid and nonparanoid schizophrenics are often treated as distinct groups (Schooler and Feldman, 1967), and as many hypotheses relating to cognitive deficit make contrasting predictions about their performance, the schizophrenic Ss were divided into separate groups on the basis of their scores on the Gordon and Gregson (1970) modification of the Symptom Sign Inventory (SSI). Patients used in the sample were those classified as being process rather than reactive, but the chronicity dimension was regarded as being continuous rather than necessarily discrete. Hence the rating scales used provided measures of chronicity which were treated as variables rather than as bases for dichotomous classification. It was hoped that more useful information would be obtained about the effects of premorbid adjustment, prolonged hospitalization, prognosis, and similar chronicity dimensions on task performance by treating these measures as potential covariates, and not as predetermined prerequisites for group membership. A fuller discussion of the problems involved in subject definition is contained in the second part of Chapter 2.

The psychiatrists responsible for each of the nine wards sampled were asked to compile a list of process schizophrenics, and these subjects' schizophrenic diagnosis was confirmed using the criteria laid down in the New Haven Schizophrenia Index, developed by Astrachan, Harrow, Adler, Bauer, Schwartz, Schwartz and Tucker (1972). Patients with a gross motor disability, or whose schizophrenic symptoms were caused by, or complicated by, demonstrable organic impairment were not included in the sample. Only patients who were aged between 19 and 60, were not receiving electro convulsive therapy, and who had no secondary diagnosis (e.g., alcoholism or mental retardation) were used in the study. Finally, patients who were currently in an acute phase of their illness, who were diagnosed schizoaffective, or who were clearly reactive schizophrenics were eliminated from the study, and hence only stabilized schizophrenics with moderately poor to very poor prognosis and premorbid adjustment (as measured on the Phillips Scale, and the Stephens and Astrup Rating

Scale, see Chapter 2), were included.

Of the Ss finally selected for testing, four were subsequently eliminated because they were too acutely disturbed to perform one or more of the tasks. Three Subjects refused to take part in the experiment and one S was rejected when it was later learnt he had undergone a leucotomy several years previously. All Ss were tested for visual acuity by requiring them to read letters presented in the apparatus in a manner similar to that used in the experimental tasks. It was found that thirteen Ss were unable to do this adequately, due either to myopia or blurring of vision as a medication side effect and these Ss did not participate in the subsequent experimental tasks. Consequently, of the total possible sample of schizophrenics resident at the hospital, only 32 or 9.5% of these were included in the final sample.

(b) Control Group Subjects:

These Ss were chosen to match the schizophrenic Ss in age, intelligence, educational and occupational status. Department of Justice Psychologists assisted in recruiting male Ss from Paparua Prison, Christchurch, New Zealand. The female Ss were chosen from amongst the staff and family members of staff at Sunnyside Hospital.

Subject Variables:

Comparisons between the three groups are presented

TABLE 5-1

GROUP MEANS AND STANDARD DEVIATIONS FOR SELECTED SUBJECT VARIABLES

		PARANOID	NONPARANOID	CONTROL
AGE	MEAN	37.5	36.8	35.06
	S.D.	10.99	12.8	12.58
	RANGE	18-56	20-60	19-56
WAIS VOCAB	MEAN	11.81	10.75	11.31
	S.D.	2.39	2.56	2.87
	RANGE	5-17	6-16	6-17
TOTAL HOSPITAL. (YRS)	MEAN	6.67	9.57	
	S.D.	7.38	10.59	
TOTAL PHILLIPS	MEAN	29.93	31.81	
	S.D.	4.85	5.31	
PHILLIPS PREMORBID	MEAN	19.12	20.06	
	S.D.	4.58	4.84	
STEPHENS-ASTRUP [1]	MEAN	6.75	7.68	
	S.D.	2.44	2.31	
% LIH	MEAN	18.13	20.77	
	S.D.	16.64	21.57	
STEVENS-ASTRUP [2]	MEAN	8.00	8.68	
	S.D.	1.94	1.44	

[1] Process Minus Nonprocess Signs

[2] Total Process Signs

in Table 5-1 for the major Subject variables. None of the possible pairwise comparisons between group age, vocabulary, length of hospitalization %LIH, and scores on the chronicity rating scales reacted significance using simple unrelated measures t-tests, (largest $t = 1.0472$, 30df, $.1<p<.2$ for the difference between the schizophrenic groups on the Stevens and Astrup Rating Scale).

The groups were also matched adequately for educational level, with 53.12% of the schizophrenics, 62.5% of the normals having less than three years secondary education. Similarly, using the Congalton-Havighurst Scale (Congalton and Havighurst, 1954) which provides a status rating of occupations in New Zealand, most Ss in all three groups fell into the lowest status categories. Twelve of the 16 Ss in the control group and in the nonparanoid group were male, and six of the paranoid Ss were female. Ten of the 16 control group members were married, while only seven of the 32 schizophrenics were married at the time of the data collection.

The three groups, nonparanoid and paranoid schizophrenics and controls were considered adequately matched for age, vocabulary, education, sex and occupational status. In terms of length of hospitalization, and percentage of life spent in hospital, the nonparanoid schizophrenics tended to have been institutionalized longer than the paranoids, although the difference did not approach significance. There were as many long stay patients in the paranoid group as there were in the nonparanoid group. The chroncity scales, based on case history data, did not significantly differentiate the two groups. Hence the two schizophrenic groups were considered sufficiently well matched.

<u>Experimental Procedure: Introduction</u>

Subjects were tested in the Psychology Department of Sunnyside Hospital.
They were told:

"At present, we are interested in finding out how quickly people are able to see things and I have some tasks here which will measure this. I am testing a number of people in this hospital because we are interested in how well people who are in hospitals, and are taking various types of drugs can do these things."

Patients were then informed that there were three parts to the experiment and that it would take about two hours to complete.

The experimental introduction for the control Ss stressed the reason for using controls, and that their performance was being used to measure possible deterioration in patients hospitalized at Sunnyside Hospital.

A pause of at least five minutes was allowed between tasks as a rest period, and the interstimulus period was controlled by the Ss - following evidence (e.g., McGhie, 1969) that Schizophrenics can perform as well as normals on some self paced tasks. All questions about any of the tasks, the apparatus or the instructions, were answered as fully as possible. Following the administration of the three experimental tasks, the shortened version of the SSI (Gordon and Gregson, 1970) and the Jastak and Jastak (1964) revision of the WAIS vocabulary were administered. At the same time, any information necessary for completion of other subject variables was obtained, if this data was not already available on patients' files.

The tasks will be discussed below in the order they were presented; the procedure, method, results and discussion pertaining to each task will be dealt with separately.

TASK 5-1; MULTIELEMENT DISPLAY PROCESSING:

Introduction:

The format of this task has been discussed elsewhere, (Chapters 1 and 3), and hence requires only brief elaboration here. The data from Chapter 3, as well as the results of Connor (1972), Donderi and Zelnicker (1969), Donderi and Case (1970), and Egeth et al. (1972) suggest a simple model to explain how Ss make same-different judgements after visually scanning randomly placed letter or geometric elements. The Ss were required to scan multielement randomly distributed arrays, in this first task, and to report whether all the letters were the same, or whether one or more of the letters was different. The task can be defined in terms of the following general stages:

(a) Categorization. The subject first scans a number of elements, and classifies them into groups based on their physical or nominal identity. It would appear (e.g., Connor, 1972) that there maybe a limit to the number of elements which can be categorized in parallel. Conventionally, where two elements only are compared for identity, then this is referred to as matching; if more than two elements are compared simultaneously, then the process can be labelled categorization. The Donderi experiments, and those of Egeth et al. (1972) have shown that where the number of elements is relatively small, categorization may proceed in parallel.

As the number of elements is increased, or where the difficulty of completing the feature tests to determine, identity is high (i.e. with degraded, or readily confused stimuli) then a series of parallel categorizations may prove necessary, possibly to the limit, where simple template matching occurs.

(b) Post Categorization Decision Point. When the S has completed any one categorization process, he has three alternatives: (a) There exist further unsampled elements, and he has insufficient information to initiate a response. Hence another categorization process must begin. (b) All elements have been scanned, and a response decision can be made. (c) Some elements have been scanned, and since more than one category has been determined, a response can be made.

(c) Response Organization and Execution. In this task classification is limited in that the Ss know that stimulus elements can only be divided into one or two categories, that is, there is only one class of different letter. Similarly the response organization is binary, with the two potential verbal response being "same" or "different". This model postulates then that Ss test the number of categories into which the elements have been divided; if there is only one (and all elements have been samples) this is translated into a same response. If at any stage more than one category is found, the categorizations and physical processes associated with scanning are terminated, and a different response is made.

The model suggested above is clearly self terminating and hybrid, with the possibility of more than one parallel categorization being carried out in series on the stimulus elements. The task can be broken down into even more steps (see Chapter 3), but the three stages above summarize the outlines of the model.

The experimental manipulations to be attempted in this task are postulated to be related primarily to Stages a and b, with the essential task demands of Stage c being held constant. Two experimental factors were involved, firstly the increasing of the number of letter elements to be categorized, and secondly the varying of the number of different "target" elements (either one or three). The first factor is clearly related to Stage a, and if the schizophrenics are less efficient at this processing Stage, then it will result in a disproportionately greater increase in response latency as a function of this factor for the patients, as compared to the controls. This may mean either that the actual number of elements sampled on each parallel categorization is less (an interpretation consistent with Neale's 1971 results) or that categorization is actually slower. The second factor is related principally to efficiency at Stage b, and to the ability to employ a successful self terminating strategy. A difference between groups on this factor will comment on decision efficiency (and this will also be reflected in a difference in error rates between groups) but interpretation will necessarily be tempered by consideration of the efficiency of functioning at the first stage - clearly adequacy of processing at a secondary level, will be dependent on the quality of information proceeding from the primary stage.

Task 5-1 can thus be related to a general scanning-processing model, and is designed to explore differences and similarities in the processing strategies of schizophrenics and normals.

Method:

(a) Experimental Design:

Eighty stimuli were used, and were similar to those used previously (Experiment 3-1). The experimental design involved manipulation of four factors. These were, (a) Group (G), and Ss were divided into three groups as defined above, (b) Response (R), that is, same or different responses were used with equal probability, (c) Degree of difference (D); the different stimuli had either one letter altered or three, and (d) Number of letters to be scanned (N). This factor had four levels, 10, 20, 30 or 40 elements.

Each stimulus card comprised a black card 20 x 10cm, with a 6.5cm square piece of white paper (with the stimulus letters), superimposed upon it, 9cm along and 1.7cm up from the bottom left corner of the black card. The prestimulus field was a card of the same dimensions with a similarly sized and positioned blank white square placed on it. For the same condition, where all elements were identical, ten cards were used for each level of N. For the different response condition, there were also ten cards for each level of N, however five of these had one letter which differed from the remainder, and the other five had three different letters.

The letters were randomly located on the white square, which for this purpose was divided into a 10 x 10 grid of 100 squares into which letters were randomly assigned using random number tables. One letter was chosen from the set E, V, N, L or I and repeated 10, 20, 30 or 40 times to form the background stimulus elements. The different stimuli were constructed by replacing one (or three) of these background letters by either G, S, O, C or B. All letters used occurred the same number of times, and in the three letter different condition, all three altered letters were identical. The letters were typed using an Olympia (Standard, 1969) model Typewriter with a carbon ribbon.

(b) Apparatus

The same apparatus was used for both tasks 5-1 and 5-2. A single channel Cambridge Tachistoscope (Model PCT 145) was connected to a Voice Operated Relay (Lafayette VOR, Model 604 A) such that when S manually initiated the tachistoscope, he simultaneously started a Lafayette digital-counter (Model 54417), which could be terminated, together with the tachistoscope, when S made a verbal response. Both clock, and tachistoscope display, stayed on until the response was made. The setting of the sensitivity reading for the VOR varied from subject to subject, and was adjusted during the practice trials.

TABLE 5-2

MEAN PROBABILITY OF ERRORS, TASK 5-1

	SUBJECTS		
Condition	Nonparanoid	Paranoid	Controls
Same	.006	.004	.006
1-different	.153	.128	.103
3-different	.044	.018	.009

(c) Procedure:

The Ss were asked to read typed letters displayed in the tachistoscope, of identical dimensions to those used in the experiment. Ss who were unable to do this readily, and without making any errors, or who complained of blurred vision were eliminated from the experiment as having inadequate visual acuity. Standardized instructions explaining the task requirements were then read to the S. Any questions asked were answered as fully as possible, and then ten practice trials were given. The eighty experimental trials were then given in random order to the S. No feedback concerning accuracy of response was given.

Results:

Error Rates:

The probability of error averaged over Ss for each of the three groups is presented in Table 5-2. Error rates were low for the same and 3-different conditions, but relatively high for the 1-different condition. The total number of errors in the combined different conditions was significantly higher for nonparanoids than for controls ($\chi^2 = 7.364$, 1df, $p < .01$), however no other pairwise between groups comparison reached significance.

Reaction Time Data:

The mean correct RTs were found, for each S for each condition, and this data is illustrated in

TABLE 5-3

MEAN AND STANDARD DEVIATIONS

SAME RESPONSE DATA: TASK 5-1

Number of Letters		Nonparanoid	Paranoid	Control
10	MEAN	1.921	2.562	1.490
	S.D	0.594	1.311	0.426
20	MEAN	2.203	3.027	1.634
	S.D.	0.740	1.524	0.415
30	MEAN	2.164	3.004	1.673
	S.D.	0.738	1.603	0.578
40	MEAN	2.238	3.219	1.678
	S.D.	0.705	1.864	0.528

SOURCE		SS	df	MS	F	
<u>Between Subj.</u>						
	Groups (G)	28.915	2	14.457	5.836	*
	Subj. w. Groups	111.48	45	2.477		
<u>Within Subj.</u>						
	Number of Letters (N)	2.19	3	0.73	19.137	**
	NG	0.0138	6	.002	0.063	
	N x Subj. w. Groups	5.151	135	.038		

** $p < .01$
* $p < .05$

<u>TABLE 5-4</u>

<u>ANOVA SUMMARY TABLE TRANSFORMED SAME RESPONSE DATA: TASK 5-1.</u>

Graph 5-1. The further analysis of data was undertaken after division of the results into same and different response data, as in Experiment 3-1, to facilitate interpretation of the experiment.

(a) Same Response Data:

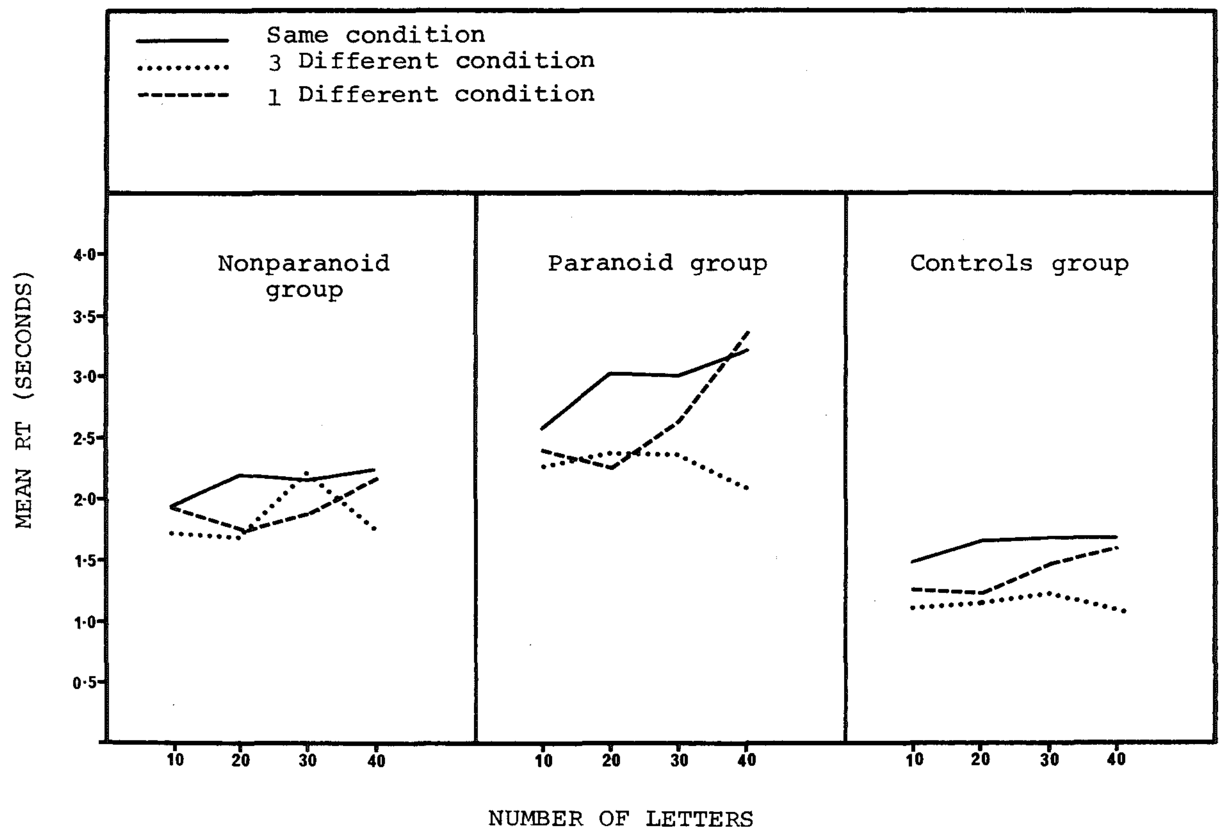
Means and standard deviations of the untransformed data for each group are presented in Table 5-3. A 3 x 4 ANOVA, with repeated measures on the final factor, N, was performed on the mean same response data of all Ss. The data was transformed using the Box - Cox criteria (Box and Cox, 1964; Wells, 1970). This procedure finds the best transformation which is defined as that transformation for which the sum of the residual error and interactions is at a minimum. The specific transformation is obtained, utilizing Bayesian procedures, from a search over a range of λ , the incremented power parameter in the equation;

$$Y^{(\lambda)} = \begin{cases} \dfrac{Y^{\lambda} - 1}{\lambda} & (\lambda \neq 0) \\ \text{Log } Y & (\lambda = 0) \end{cases}$$

In this case a best lambda value of -0.40 was found, and a summary of the ANOVA with the transformed data, appears in Table 5-4.

The G main effect was found to be significant ($p < .05$) and further analysis was undertaken to highlight the interpretation of this result. Using means from the transformed data ($\lambda = -0.40$), orthogonal comparisons using the t-statistic, based on the studentized t - distribution (Kirk, 1969), were computed to test the

GRAPH 5-1
Mean untransformed same and different response latencies, Task 5-1



significance of the difference between the paranoid and nonparanoid groups' means, and then the combined schizophrenic group, and control group means. The difference between the two schizophrenic groups was nonsignificant ($t = 1.466$, 45df, $p < .10$), although the nonparanoid RTs were consistently greater. However the combined paranoid, nonparanoid mean RT was significantly greater than that of the control group ($t = 2.672$, 45df, $p < .01$).

The significant N main effect ($p < .01$) indicated that RT increased, as the number of letters to be processed increased. The NG interaction did not approach significance. This demonstrated (as in Graph 5-1) that the slope of the function relating RT to number of letters per stimulus, is equivalent for the three groups. Paranoid and nonparanoid schizophrenic scanning rates did not therefore increase more rapidly than those of the controls, although in absolute terms, the schizophrenics RT was greater.

(b) <u>Different Response Data</u>:

The means and standard deviations of this data is presented in Table 5-5. A 3 x 2 x 4 ANOVA with repeated measures on the last two factors, D and N, was performed on the mean transformed data (again using the Box - Cox method, $\lambda = -0.80$). A summary of this appears in Table 5-6.

The ANOVA summary table illustrates that there is a strong group main effect ($p < .01$). The paranoid Ss, with both the same and different response data, have slower RTs than the nonparanoids, who are in turn slower than the controls (Table 5-5).

TABLE 5-5

MEAN AND STANDARD DEVIATIONS

DIFFERENT RESPONSE DATA: TASK 5-1

Number of Letters		Nonparanoid	Paranoid	Control
1-different				
10	MEAN	1.902	2.393	1.263
	S.D.	0.682	1.322	0.335
20	MEAN	1.768	2.276	1.221
	S.D.	0.683	1.326	0.298
30	MEAN	1.895	2.613	1.462
	S.D.	0.531	1.298	0.493
40	MEAN	2.179	3.346	1.590
	S.D.	0.773	2.495	0.490
3-different				
10	MEAN	1.721	2.234	1.167
	S.D.	0.795	1.574	0.283
20	MEAN	1.685	2.369	1.130
	S.D.	.798	1.367	0.248
30	MEAN	2.202	2.372	1.204
	S.D.	1.035	1.397	0.313
40	MEAN	1.742	2.082	1.086
	S.D.	0.753	1.111	0.278

SOURCE		Ss	df	MS	F	
Between Subj.	Groups (G)	54.147	2	27.073	11.291	**
	Subj. w. Groups	107.899	45	2.397		
Within Subj.	Number of Letter (N)	5.750	3	1.916	22.610	**
	NG	1.265	6	0.210	2.488	*
	N x Subj. w. Groups	11.444	135	0.084		
	Different Targets (D)	2.961	1	2.961	42.189	**
	DG	0.209	2	0.104	1.494	
	D x Subj. w. Groups	3.158	45	0.070		
	ND	2.463	3	0.82	11.58	
	NDG	0.655	6	0.109	1.542	
	ND x Subj. w. Groups	9.560	135	0.070		

** $p < .01$

* $p < .05$

TABLE 5-6

ANOVA SUMMARY TABLE OF THE TRANSFORMED DIFFERENT RESPONSE DATA: TASK 5-1

Similar t-statistics to those computed for the same response data, using the means of the Box - Cox transformed data for this pupose were calculated to explore this main effect (Kirk, 1969; p.306). There was no difference between the two schizophrenics groups at either level of D (1 - different, $t = 1.583$, 45df, $p < .1$; 3-different, $t = 1.423$, 45df, $p < .10$). The mean RT of the combined schizophrenic groups was significantly greater than that of the normal group at both levels of D (1-different $t = 4.822$, $p < .0005$; 3-different, $t = 6.352$. 45df, $p < .0005$).

The ANOVA results also showed that as N increased, RT also increased ($p < .01$). The interaction between N and G was also significant ($p < .05$), but this effect was weak in comparison to the absolute differences in RT. This interaction suggests a difference in scanning rates for different stimuli between groups, and is probably the result of the more rapid increase in RT for the paranoid group, in the 1-different condition, in relation to the other two groups (Graph 5-1). The significant D main effect ($p < .01$) indicated that as degree of difference was increased from one to three letters altered, RT was decreased. There was no tendency for this effect to vary between groups, as the nonsignificant DG interaction showed.

Relation between Task Performance and Selected Subject Variables:

For Task 5-1, a total untransformed RT accumulated across all levels of N, the number of

TABLE 5-7

CORRELATION BETWEEN SELECTED SUBJECT VARIABLES AND STANDARDIZED TASK VARIABLES:

TASK 5-1:

SCHIZOPHRENIC SUBJECTS (N = 32):

Subject Variables	Standardized Task Variables: Same Response	Standardized Task Variables: Different Response
Age	0.436 *	0.496 **
Vocab.	-0.196	-0.243
Total Phillips	-0.206	-0.098
Phillips Premorbid	0.037	0.096
Stephens - Astrup [1]	-0.046	0.029
Total Hospital (yrs)	0.01	0.119
% LIH	0.215	0.315

Table 5-7 (cont) CONTROL SUBJECTS (N = 16):

Subject Variables	Standardized Task Variables	
	Same Response	Different Response
Age	0.261	0.291
Vocab	0.151	0.134

[1] Total Process Signs

* $p < .05$

** $p < .01$

letters on each display, was found for each S, for the same response data, and for both the 1-different and 3-different conditions, to give three totals for each subject. The respective total RTs for each subject on each condition were then expressed as standardized z-scores, relative to the mean and standard deviations of the total RTs of the subjects from all three groups, combined on the appropriate condition. The z-scores of each Subject for the two different response conditions were then averaged to give a mean z-score for the 1 - different and 3 - different conditions combined.

The resulting two standardized scores, one for the same, and one for the different response data were correlated with selected subject variables, as shown in Table 5-7. The only significant correlations found were for the schizophrenic Ss, between mean response latency, and age. Since age was correlated highly ($r = .723$, 30df, $p < .01$) with % LIH, the next highest positive correlation in Table 5-7, a partial correlation analysis (Smillie, 1966) was performed to determine the effects due to age, with those resulting from % LIH held constant. The partial correlation of age with the standardized same response data, $r = 0.427$, was found to be significant ($t = 2.373$, 27df, $p < .05$), as was the partial correlation for the different response data, $r = 0.415$, ($t = 2.324$, 27df, $p < .05$). Thus the significance of the correlation between age and mean response latency is largely independent of the effects of % LIH.

Discussion:

The results of this first task admit to two relatively strong conclusions. Firstly, schizophrenics and normals appear to process information in a similar manner, and the functions relating RT to increases in quantity of information did not markedly differ between groups. This statement requires some qualification however. As is apparent in Graph 5-1, there was a difference in scanning rates between the paranoid group, and the other two groups, especially in the 1-different condition. The significant NG interaction (Table 5-6) reflects this trend. The differences between groups however, due to differential rates of increase in RT as a function of N, are minimal when related to the large differences in absolute RT. These differences, being relatively constant over both N and D, point to either a decrement of response organization and commission, or a slowness in initiating the scanning process, or possibly both. Although paranoids were consistently slower than nonparanoids, there was however no significant difference between these two groups.

Secondly the decrement is strongly correlated with age differences, even when a measure of the length of institutionalization (%LIH) is held constant in partial correlation analysis. Clearly older schizophrenics have a slower simple RT than same age normals although this may be the result of prolonged medication, or ECT.

In terms of the model outlined in the introduction to this section, and described in more detail in Chapter 3, it would appear that categorization proceeds as rapidly with schizophrenics as with normals. The negatively accelerated same response curve which was discussed in Chapter 3 holds also for all the Ss of this experiment. There was also a clear difference for all groups between the one, and three different curves suggesting a self terminating strategy. The marked difference between same and 1-different response data, which was apparent in the second experiment of Chapter 3 was not so readily discernable in the results of this experiment. The only hint of any inefficiency at either Stage a or Stage b was the higher error rate (Table 5-2) which discriminates the nonparanoids from the control Ss, in the 1-different condition. These patients appear either to prematurely terminate categorization or to misidentify elements more commonly than do normals. The general slowness of RT, which most obviously discriminates between groups, may well be due primarily to an inability to organize a response or to translate from the information resulting in classification, to a verbal response. However it is also possible that the physical effects of making a response although minimized by using vocal RT, or the Ss orientation towards the stimulus, despite the fact that presentation rate was subject controlled, may have contributed to the constant deficit in response latency of the schizophrenics.

TASK 5-2 MULTIELEMENT VISUAL COMPARISON

Introduction:

The format and general theoretical basis of this experiment has been discussed in detail elsewhere (Chapter 4). The subject was required, as in previous experiments, to report "same" or "different" to two groups of letters which might be either words or nonwords. The aims of the experiment were largely to explore the use of this task with schizophrenic Ss. Scanning rate (as measured by vocal RT) was also evaluated in relation to selected subject variables enumerated in Task 5-1. The purpose of the experiment was to demonstrate how schizophrenics responded to increased letter group length, and the structural redundancy induced by using word as opposed to nonword stimuli, and their performance was compared and contrasted with those of the normal control Ss.

Method:

(a) Apparatus:

This was the same as that used for Task 5-1.

(b) Experimental Design and Stimuli:

The experimental format was a 3 x 2 x 2 x 4 factorial design with repeated measures on all factors except the Groups (G) factor. The repeated factors were, (a) Response (R), same or different, (b) Stimulus Structure (W), word or nonword, and (c) Number of letters (3, 4, 5 or 6) to be compared, (N). There were 80 stimulus cards in all, five for each combination of the stimulus factors, W, R, and N.

Each stimulus comprised a black card of the same dimensions as the cards used in Task 5-1, with a 7.6 x 2.5cm rectangular piece of white paper superimposed 1 cm along, and 1.5 cm up from the bottom left corner of the card. The distance from first to last letter was a constant 3.7cm. The selection and construction of the word and nonword stimuli was as described in Experiment 4-3. The different stimuli had only one letter altered, and this was chosen at random from the letter group.

(c) Procedure:

The eighty stimuli were presented to all Ss in the same random order, and Ss were told:

"This next task uses the same equipment as you used last time.
However, the cards are different this time. For example you will see that there are two groups of letters or two words on the card. Your job is to say out loud as quickly as possible whether or not the letters are the same on this side (pointing) as they are on this side (pointing)."

Ss were warned to be quiet after the stimulus had been presented, until making a response and were told to call out "same" for the same stimuli and "different" for the different stimuli. Six practice trials were given with stimuli similar to those used in the experiment proper. After the first task,

		Nonparanoid	Paranoid	Controls
WORDS	SAME	0.009	0.000	0.000
WORDS	DIFFERENT	0.025	0.047	0.022
NONWORDS	SAME	0.016	0.012	0.028
NONWORDS	DIFFERENT	0.066	0.081	0.062

Table 5-8

PROBABILITY OF ERRORS, TASK 5-2

Ss experienced little difficulty generalizing to the new stimuli.

Results:

Error Rates:

As can be seen in Table 5-8 the probability of error for this task was somewhat less than for Task 5-1. Again there was a tendency for different responses to produce more errors, and in this task errors were more frequent in the less structured nonword condition. Error rates were comparable between groups.

Reaction Time Data:

The response latencies for each S were treated in a manner similar to that reported for task 5-1. The group means, pooled over all Ss, are represented in Graph 5-2.

To render more efficient the analysis and interpretation of results, the same response, and the different response data are discussed separately.

(a) Same Response Data:

The means and standard deviations of the untransformed data are presented in Table 5-9. These statistics indicate that the schizophrenic Ss have a greater mean RT and between subject variability than do the controls. The mean RTs for all Ss were transformed using the Box - Cox criterion ($\lambda = -0.60$). The results of a 3 x 2 x 4 ANOVA, with repeated measures on the final two factors, W and N, are reported in Table 5-10.

GRAPH 5-2
Mean untransformed response latency for the 3 groups, to the word and nonword stimuli, as a function of number of letters to be compared. Task 5-2

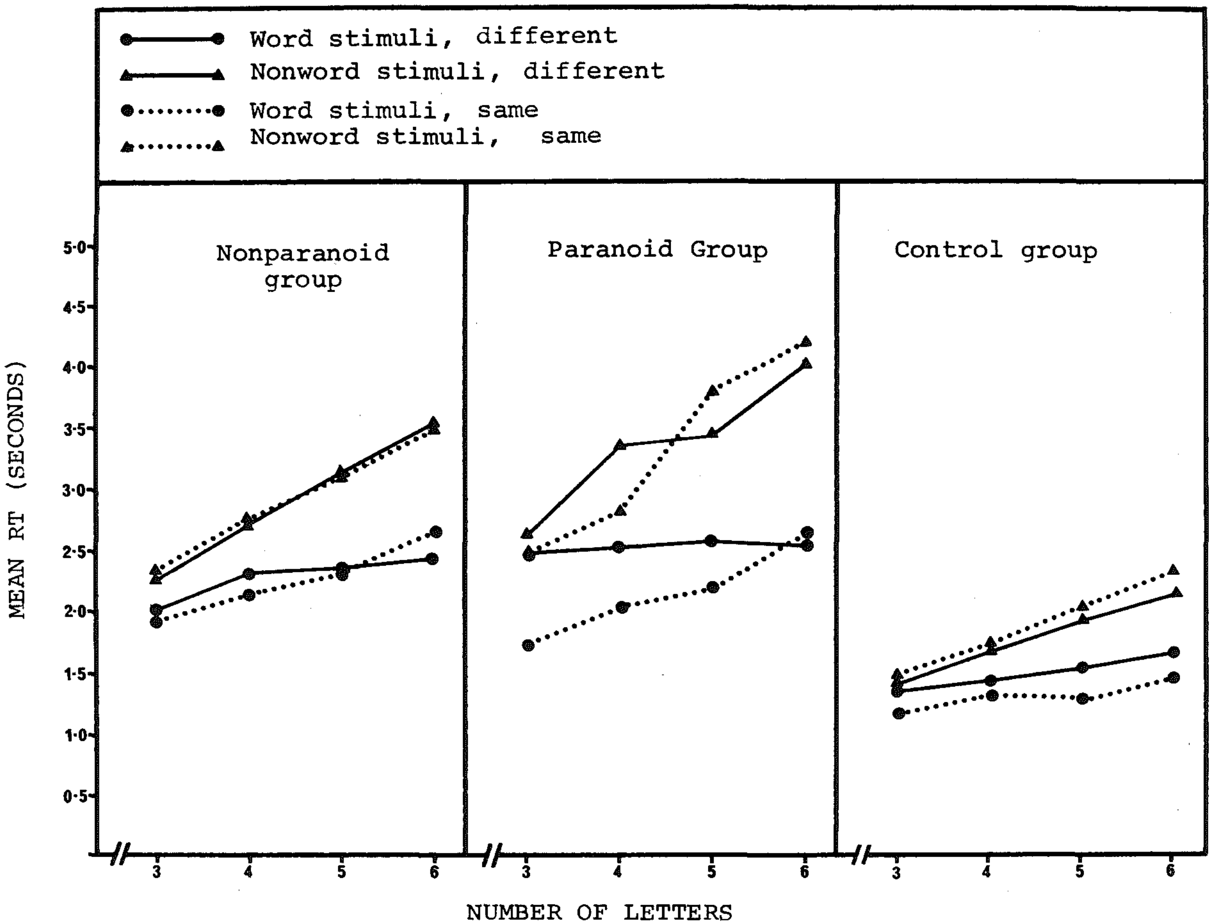


TABLE 5-9

MEANS AND STANDARD DEVIATIONS OF THE UNTRANSFORMED SAME RESPONSE DATA TASK 5-2.

WORDS	Nonparanoid		Paranoid		Controls	
No. of Letters	Mean	S.D.	Mean	S.D.	Mean	S.D.
3	1.928	0.650	1.713	0.494	1.134	0.218
4	2.145	0.733	2.035	0.597	1.345	0.227
5	2.314	0.988	2.193	0.679	1.333	0.269
6	2.650	0.974	2.650	0.973	1.475	0.309
NONWORDS						
No. of Letters.						
3	2.459	0.653	2.469	0.847	1.496	0.305
4	2.74	0.851	2.877	1.049	1.717	0.458
5	3.145	0.957	3.836	1.816	2.034	0.608
6	3.488	1.173	4.219	1.753	2.346	0.693

SOURCE	S.S.	df	M.S.	F	
Between Subj.					
Groups (G)	89.093	2	44.546	18.849	**
Subj. w. Groups	106.349	45	2.363		
Within Subj.					
Stimulus Structure (W)	47.110	1	47.110	131.245	**
WG	1.098	2	0.549	1.529	
W x Subj. w. Groups	16.153	45	0.359		
No. of Letters (N)	30.301	3	10.100	85.449	**
NG	0.512	6	0.085	0.722	
N x Subj. w. Groups	15.957	135	0.118		
WN	1.361	3	0.454	5.208	**
WNG	0.455	6	0.076	0.871	
WN x Subj. w. Groups	11.762	135	0.087		

TABLE 5-10

ANOVA SUMMARY TABLE, SAME RESPONSE DATA: ($\lambda = -0.6$): TASK 5-2 $**p < .01$

The significant G main effect ($p < .001$) prompted further investigation of between group differences. There was no difference between the two schizophrenic groups, with either the word stimuli ($t = 0.55$, 45df) or the nonword stimuli ($t = 0.845$, 45df). There was however a significant difference between the mean RTs of the combined schizophrenic groups and that of the controls, in both the word ($t = 7.495$, 45df, $p < .001$) and the nonword ($t = 6.516$, 45df, $p < .001$) conditions. The schizophrenic Ss therefore showed significantly retarded response latencies in both the word and nonword conditions.

There is also a strong W main effect ($p < .001$) indicating that Ss respond more rapidly to words than to nonwords. As the nonsignificant WG interaction revealed, this difference was consistent across groups. A significant N main effect was also present ($p < .001$); however the NG interaction was nonsignificant. Thus RT increased as N increased, and this trend did not differ between groups, within the range of N used.

The significance of the WN interaction ($p < .01$) demonstrates that differences in RT between words and nonwords may depend on the number of letters to be compared. This is evident in Graph 5-2 where the rate of increase in RT due to N is less for words than it is for nonwords.

(b) <u>Different Response Data:</u>

A summary of the means and standard deviations

TABLE 5-11

MEANS AND STANDARD DEVIATIONS OF THE UNTRANSFORMED DIFFERENT RESPONSE DATA TASK 5-2

WORDS No. of Letters.	Nonparanoid Mean	Nonparanoid S.D.	Paranoid Mean	Paranoid S.D.	Controls Mean	Controls S.D.
3	2.045	0.508	2.462	1.163	1.348	0.257
4	2.341	0.635	2.510	0.899	1.423	0.285
5	2.355	0.693	2.563	0.989	1.538	0.345
6	2.431	0.756	2.548	0.857	1.651	0.444
NONWORDS No. of letters						
3	2.259	0.659	2.613	0.963	1.387	0.270
4	2.723	0.761	3.369	1.759	1.651	0.437
5	3.146	0.857	3.418	1.028	1.917	0.475
6	3.554	1.164	4.080	1.560	2.136	0.618

SOURCE	S.S.	df	M.S.	F
Between Subj.				
Groups (G)	109.782	2	54.891	19.467 **
Subj. w. Groups	126.886	45	2.819	
Within Subj.				
Stimulus Structure (W)	19.302	1	19.302	117.126 **
WG	0.242	2	0.121	0.735
W x Subj. w. Groups	7.420	45	0.165	
No. of Letters (N)	19.754	3	6.585	64.939 **
NG	1.049	6	0.175	1.724
N x Subj. w. Groups	13.689	135	0.101	
WN	4.004	3	1.335	17.680 **
WNG	0.069	6	0.012	0.152
WN x Subj. w. Groups	10.198	135	0.076	

TABLE 5-12 ANOVA SUMMARY TABLE DIFFERENT RESPONSE DATA, TRANSFORMED ($\lambda = -0.60$): TASK 5-2

** $p < .01$

of the untransformed data is displayed in Table 5-11. The relationship between this data and the same response data is portrayed in Graph 5-2. The ANOVA reported in Table 5-12 was performed on transformed data (Box and Cox, $\lambda = -0.60$). As the ANOVA summary table illustrates, the overall pattern of the data is similar to that of the same response data. There was a significant G main effect, and this was revealed to result from a difference between the combined schizophrenics group mean and that of the controls for both words ($t = 7.1$, 45df, $p < .001$) and the nonwords ($t = 7.639$, 45df, $p < .001$). There was no difference between the means of the two schizophrenic groups for either the word condition ($t = 0.813$) or the nonword condition ($t = 1.325$). The results on this analysis show then that the schizophrenics had slower RTs, but that there were no paranoid - nonparanoid differences in this respect.

There was a highly significant W-main effect ($p < .001$) and the WG interaction was again non significant. Thus, while there was a difference between words and nonwords, this did not vary between groups. The N-main effect is also strong, and as the nonsignificant NG interaction indicates, consistent over groups. Thus while increases in the N-factor were associated with an increase in RT, this trend is uniform over both the schizophrenic and the control groups. The significant WN interaction shows that in some cases, the difference

TABLE 5-13

CORRELATION BETWEEN SELECTED SUBJECT VARIABLES

AND TASK VARIABLES: TASK 5-2:

SCHIZOPHRENIC SUBJECTS (N = 32):

	Standardized Task Variables	
	Same Response	Different Response
Age	0.461 **	0.453 *
Vocab.	-0.260	-0.298
Phillips Total	-0.114	-0.081
Phillips Premorbid	-0.046	-0.047
Stephens-Astrup [1]	-0.125	-0.082
Hospitalized (yrs)	0.143	0.176
% LIH	0.281	0.312
CONTROLS (N = 16)		
Age	0.171	0.115
Vocab.	0.026	0.021

[1] Process Minus Nonprocess Signs.

* $p < .05$

** $p < .01$

between words and nonwords was dependent on the number of letters to be scanned. This implies a difference in scanning rates between words and nonwords, which did not differ between groups and is clearly illustrated in Graph 5-2.

(c) Relation Between Task and Subject Variables:

For both the same and different response conditions, a mean was found for each S across the N-factor for both the word and nonword conditions, and these means were expressed as standard scores. The mean standard score for each S was then found for the combined word and nonword same response data, and for the similarly combined different response data. These two means were subsequently correlated with selected Subject variables and the results presented as Table 5-13. The only significant correlations are those between age and the task variables for all schizophrenic Ss. Since the correlation between age and % LIH is high ($r = 0.723$, $p < .01$, 30df), and % LIH is also correlated relatively highly with the task variables, partial correlations were computed between age and the standardized mean response latencies, with % LIH held constant (Smillie, 1966). The partial correlation $\rho = 0.306$ of the same response data with age (with % LIH held constant) was not significant ($t = 1.732$, 29df, $p < .10$). However a similar partial correlation with the different response data, $\rho = 0.346$, was significant ($t = 1.989$, 29df, $p < .01$). Overall RT would appear to be slower in older patients, even when the influence of % LIH is partialed out. The

TABLE 5-14

CORRELATIONS BETWEEN PDI, SELECTED SUBJECT VARIABLES: TASKS 5-1 AND 5-2.

(SCHIZOPHRENIC SUBJECTS, N=28)

	Correlation with PDI
Age	0.372
%LIH	0.329
Hospitalization (Yrs)	0.194
TASK 5-1	
Same Response	0.316
Different Response	0.351
TASK 5-2	
Same Response	0.414 *
Different Response	0.525 **

** p<.01

* p<.05

correlation may still be confounded in that older Ss have had more prolonged chemotherapy, and ECT, and possibly in amounts not necessarily related to % LIH.

(d) <u>The PDI, and Tasks 5-1 and 5-2:</u>

The first two tasks both yielded significant between groups differences, and accordingly an exploratory correlation analysis was undertaken to determine to what extent task performance of schizophrenics was related to PDI. For the purposes of this analysis, four Ss whose drug regimen was unstable prior to testing, were removed from the sample. The mean PDI was 6.856, and the S.D. was 4.475. The task variables used were the standardized same and different response data from Tasks 5-1 and 5-2. The derivation of these values for each S is outlined above.

As can be seen from Table 5-14, significant correlations were found between the PDI, and the standardized Task 5-2 variables. Thus, for Task 5-2, the patients who had high mean RTs, also were receiving the greatest phenothiazine dosages. The PDI was not however significantly correlated with age or length of institutionalization, although a positive trend is apparent in the correlational results. It can be concluded tentatively therefore that high phenothiazine dosages, together with age and institutionalization (Table 5-13), interacted with measures of performance on Task 5-2. The reason for the nonsignificant correlation between Task 5-1 variables, and PDI is not however readily apparent.

<u>Discussion:</u>

The results of this task were similar to those of Task 5-1. Analysis of the RT data showed that increasing the number of letters to be compared (over the small range of three to six), did not differentially effect schizophrenics as compared to normal controls. There was no difference in absolute RT between the paranoid and nonparanoid groups, and error rates were equivalent across the three groups.

Processing strategies seemed however similar between groups (Graph 5-2) and similar to the results of Chapter 4, with the noticeable exception of the paranoid Ss in the word condition (different response). The very small increase in RT as a function of letters compared for these Ss appears to defy any obvious explanation. The reason for the similarity of slopes between the same and different response conditions may lie in the way Ss appear to scan "chunks" of one letter group (in parallel) and compare them with similar size chunks of the other. These chunks tend toward being about three to four letters for nonwords, and are much greater for words. Hence, with five or six letter stimuli the probability of the changed letter being in the last two processed elements is too slight to influence mean RT. With larger 8, 10 or 15 letter comparisons, this process of comparison by chunks may become more pronounced.

Both Task 5-1 and 5-2 have demonstrated that schizophrenics have a slower simple RT, a fact well established previously (e.g., Shakow, 1972a; Bauman, 1971; Royer and Friedman, 1973), when compared to normal controls. Both tasks have shown that conjectures by Yates (1966a), McGhie (1969), and others, that stimulus complexity differentially effects schizophrenics, are not necessarily true, or at least of minimal importance in relation to the large constant difference in RT. As can be seen in Graph 5-2, scanning rates may be slower for patients, but this difference between groups does not commonly reach significance. This may imply that with relatively small amounts of information, differences in scanning rates may be "swamped" by slowness in speed of response selection.

TASK 5-3: VISUAL SEARCH

Introduction

This experiment was based on the work of Neisser (1967) and his colleagues (reviewed more extensively in Chapter 1). Subjects were required to search for a predesignated target letter embedded in one of 50 rows of letters, each row consisting of four letters. The context letters in which this target appeared were either angular or round, and since the target was angular (the letter X) it was hypothesized that search would proceed more rapidly in the round letter context (evidence for this is provided by Rabbitt 1964a, 1967a, and Neisser, 1963).

Neisser (1963) demonstrated that a linear regression line could be fitted to the data relating number of letters scanned to RT. It was therefore proposed to regress the data gathered in a similar manner, and hence obtain a (intercept) and b (slope) values for the linear relation $RT = a + bx$, where x refers to number of letters scanned, and to calculate an F-ratio as a measure of goodness of fit. Using the simple additive model of Neisser (1963) a high value of the intercept a, would indicate a slow response time (i.e. time taken to recognize the target and call out a response) and a high b-value or slope would indicate a slow rate of scanning. The higher the F-ratio the better the fit of the fluctuations in performance. These parameters were compared for the angular and round letter conditions,

FIGURE 5-1

APPARATUS TASK 5-3

(the context factor C) and were related to number of errors and selected subject variables.

(a) Apparatus:

The major modification of this experiment in relation to those of Neisser, was in the apparatus. In Neisser's task all the letters were simultaneously exposed to the Ss, while the present study, Ss viewed only one four letter row at a time. The apparatus is pictured in Figure 5-1. A wooden rectangular box 45.5cm high, with a base 30.4cm x 20.3cm, and with an aluminium front sloping 45° away, from the base was constructed so that the S was able to pull down a stimulus card past a slit (2.5cm x 0.7cm) in the front of the box. Each stimulus card was slipped into a 2.3cm x 7.5cm metal carriage and the card was moved downwards, by means of two large plastic knobs, so that successive rows of letters would be exposed one at a time, in the rectangular slit for as long as the S required. The carriage was connected to the top of the apparatus by means of a strip of rubber, so that when the two knobs were no longer being held down, the carriage and the card returned to the top of the box. Very little pressure was needed to pull the stimulus card downwards, and the stimulus letters could readily be exposed faster than the Ss could scan them. Thus, speed of scanning was in no way limited by friction in the system.

When the first letters of a stimulus card were exposed in the slit, a contact was made and this sta the digital timer (as used in Task 5-1 and Task 5-2)

VOR stopped this clock when the S signified he had located the target letter. The Ss then held the card in position and the experimenter verified that a target had been found.

(b) Stimuli:

Subjects were instructed to search through random letter lists 50 letters long, for the letter X. Each stimulus card was made from black cardboard 20.3cm long 7.2cm wide. Onto this card was superimposed the letters printed on white paper, with the first four letter unit being 1.7cm from the top of the black cardboard, and 3.1cm from the RHS of the card.

A program to produce random letters was written for an IBM 360/44 computer, based on the IBM 360 Scientific Subroutines Package RANDU Subroutine, which randomly ordered the background letters and positioned the target letter X (which appeared only once on each stimulus card) and printed them using a standard lineprinter. Forty stimulus cards were used. The round background letters O,C,G,S, and Q appeared on half the cards the remaining half used the angular letters E,V,L,N and I.

(c) Procedure:

Half the Ss in each group received the angular letters first, and half received the round letter stimuli first.

The working of the apparatus was explained to the Ss, and all questions were answered. Subjects were then shown the stimulus cards and told to find the X without the apparatus. Then they were asked to use the apparatus:

"I want you again to look down the list for the letter X, and then to call out "stop" so that the microphone will turn the clock off. Then you may release the two knobs and we can begin again. Do not start until I say "ready" and remember to call out "stop" as quickly as you can."

Subjects were told that if they reached the end of the list without finding an X, they were not to go back and look for it. They were then given five practice trials with cards similar to those used in the experiment.

Following this, half the Ss were told that they would be seeing twenty cards with angular letters as a background and then twenty cards with round letters. The order of the presentation was reversed for the other half of the Ss. The stimuli were presented in random order: if some noise turned off the VOR prematurely the trial was immediately terminated and another stimulus card, not used in the standard set, but of identical construction was substituted.

Results:

Following the work of Neisser (1967) it was anticipated that the data pertaining to this task would produce a strong linear trend between letter units

TABLE 5-15

MEAN AND STANDARD DEVIATIONS OF SLOPE, INTERCEPTS AND F-RATIOS: TASK 5-3.

Round Letter Condition

		Intercept	Slope	F-Ratio
Nonparanoid	Mean	0.659	0.346	193.990
	S.D.	1.033	0.120	183.148
Paranoid	Mean	0.692	0.365	134.169
	S.D.	1.593	0.258	124.534
Controls	Mean	0.269	0.287	275.764
	S.D.	0.623	0.087	113.497

Angular Letter Condition

		Intercept	Slope	F-Ratio
Nonparanoid	Mean	0.982	0.345	124.961
	S.D.	1.118	0.141	98.043
Paranoid	Mean	0.698	0.422	87.588
	S.D.	1.419	0.334	69.969
Controls	Mean	0.625	0.294	158.968
	S.D.	0.561	0.012	119.580

scanned and RT. Graphs 5-3 and 5-4 essentially substantiate this. Accordingly, it was decided to fit regression lines to the data of each S, one for the results of the angular condition. Hence each S provided six result variables, the intercept and slope for round and angular conditions, and the F-ratio measuring goodness of fit for both round and angular letter conditions. The group means of these derived measures are given in Table 5-15. Only those trials on which the S detected the target elements were used in the calculation of these measures.

The preliminary investigations of these mean slope, intercept and F-ratio values suggest that paranoid schizophrenics can less quickly (i.e., have the greater slope values) than do nonparanoids, who are slightly slower than the controls. The control group has higher F-ratios and smaller intercept values than the schizophrenic groups. To investigate these trends further, a more detailed analysis was performed on each of these variables.

<u>Error Rates</u>:

The probability of error on this task is summarized for each condition in Table 5-16. An analysis of the total error frequences revealed a significant difference ($\chi^2 = 32.128$, 2df, $p < .001$). There was however no difference between schizophrenic groups in either condition. Significant differences were found between the paranoids and the controls ($p < .01$) and the nonparanoids and controls ($p < .005$), in both conditions. The schizophrenics made significantly more errors than the controls, and these

TABLE 5-16

PROBABILITY OF ERROR. TASK 5-3

	Angular Context	Round Context
Paranoid	0.156	0.069
Nonparanoid	0.200	0.081
Controls	0.069	0.019

SOURCE	S.S.	df	M.S.	F
Between Subj.				
Groups (G)	2.310	2	1.155	0.505
Subj. w. Groups	103.007	45	2.289	
Within Subj.				
Context (C)	1.259	1	1.259	3.706
GC	0.595	2	0.297	0.875
C x Subj. w. Groups	15.286	45	0.339	

TABLE 5-17

ANOVA SUMMARY TABLE, INTERCEPT DATA: TASK 5-3

SOURCE	S.S.	df	M.S.	F
Between Subj.				
Groups	0.169	2	0.085	1.093
Subj. w. Groups	3.496	45	0.078	
Within Subj.				
Context (C)	0.011	1	0.011	2.213
GC	0.016	2	0.008	1.649
C x Subj. w. Groups	0.215	45	0.005	

TABLE 5-18

ANOVA SUMMARY TABLE, SLOPE DATA: TASK 5- 3

SOURCE	S.S.	df	M.S.	F	
Between Subj.					
Groups (G)	180810.625	2	90405.313	5.209	**
Subj. w. Groups	780890.125	45	17353.114		
Within Subj.					
Context (C)	144807.063	1	144807.063	18.309	**
GC	20969.160	2	10484.578	1.326	
C x Subj. w. Groups	355909.616	45	7909.103		

** $p < .01$

TABLE 5-19

ANOVA SUMMARY TABLE, F-RATIO DATA: TASK 5-3

	Schizophrenics						Controls	
	Age	Vocab	Phillips Total	Stephens Astrup[1]	Years Hospt	% LIH	Age	Vocab
Errors	0.190	0.133	0.194	0.301	0.267	0.303	-0.422	-0.382
<u>Round Condition</u>								
Intercept	0.252	0.222	0.250	0.216	0.348	0.112	0.058	-0.407
Slope	0.233	-0.215	-0.238	-0.103	-0.007	0.267	-0.122	-0.243
F-ratio	-0.152	-0.239	-0.055	-0.007	-0.006	0.067	0.204	0.421
<u>Angular Condition</u>								
Intercept	0.217	0.045	0.300	0.189	0.460*	0.291	-0.006	0.065
Slope	0.170	-0.105	-0.308	-0.078	-0.158	0.099	0.022	-0.049
F-ratio	-0.112	0.051	-0.076	-0.026	-0.107	-0.140	0.093	-0.014

1 Process Minus Nonprocess Signs
*$p < .05$

<u>TABLE 5-20</u>

<u>CORRELATION BETWEEN TASK AND SELECTED SUBJECT VARIABLES</u>

errors took the form of failure of identification and not of false identification of the target.

Reaction Time Data:

The slopes, intercepts and F-ratios were separately treated by three 3x2 ANOVAs with repeated measures on the Context Factor (C). The data in each case was not sufficiently distorted to require transformation, and consequently the untransformed data was used for each analysis.

(a) Intercepts:

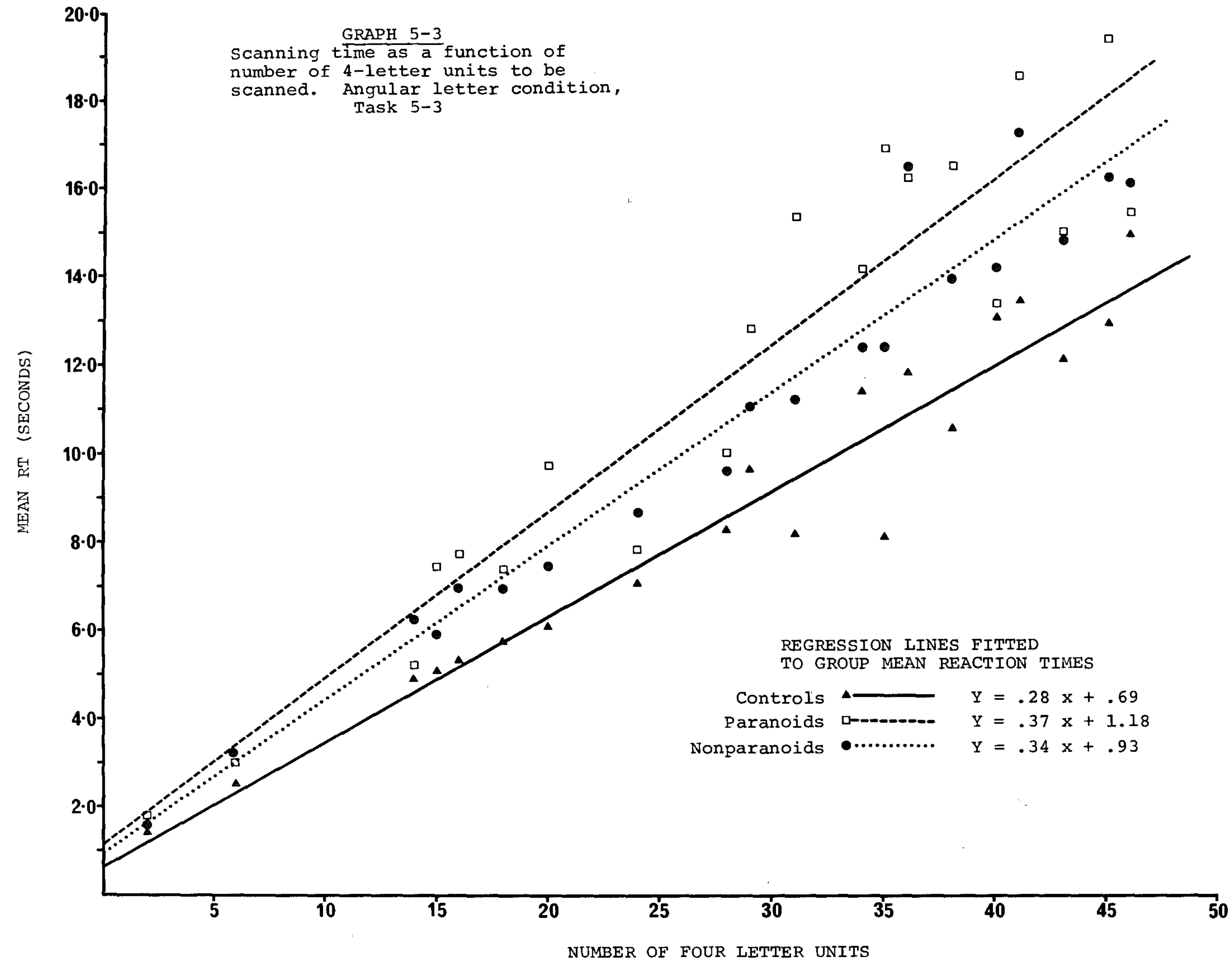
The ANOVA summary table for the intercept data is presented as Table 5-17. There were no significant F-ratios indicating that the schizophrenics did not differ from the controls, in this task, in this measure which was hypothesized to be related to the constant time required to select and execute the response. There was also no difference between context conditions.

(b) Slopes:

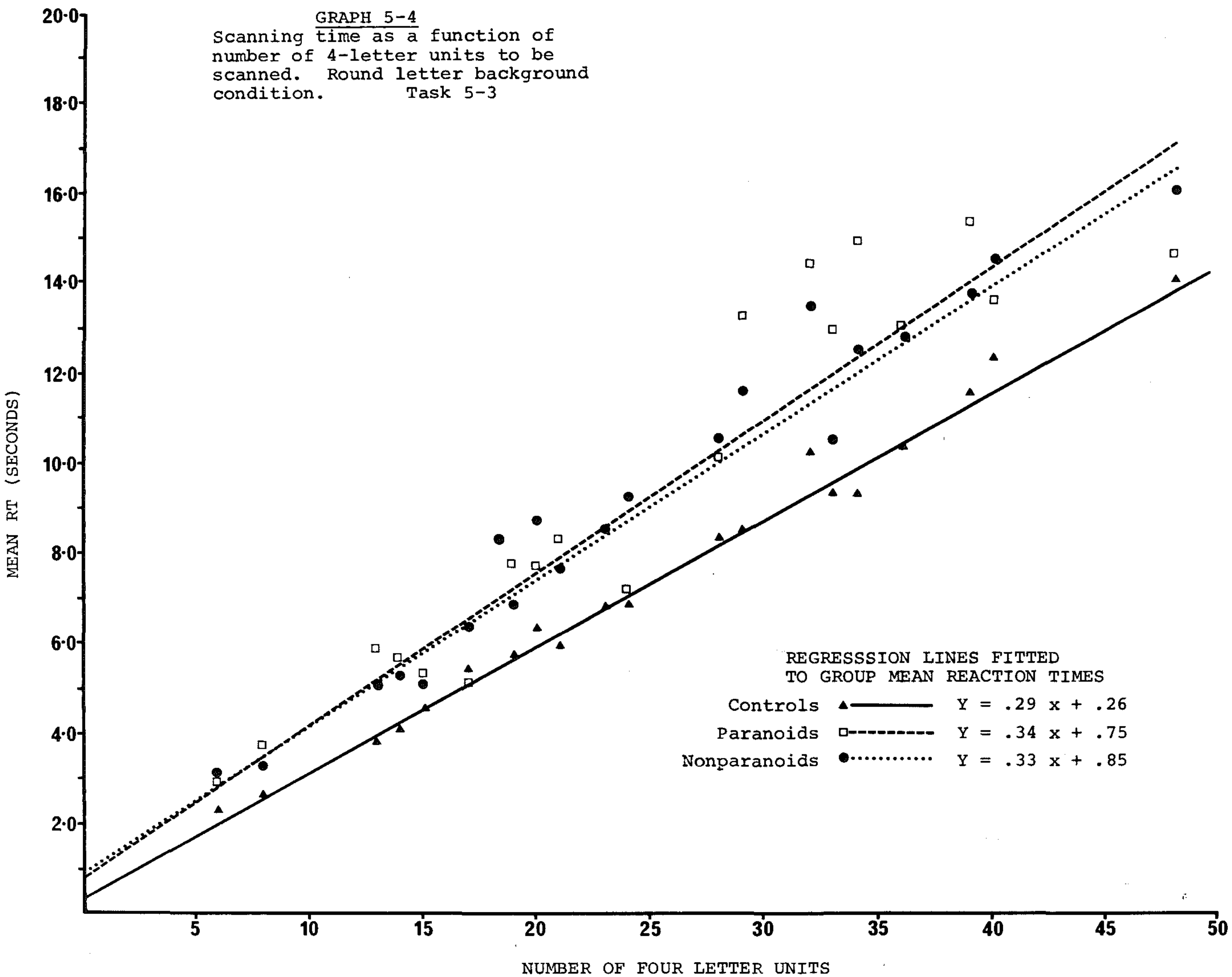
The result of the ANOVA performed on the slope coefficient data is presented as Table 5-18. Again, there were no significant maineffects or interaction, indicating no between group differences or differences due to context. The tendency towards slope differences apparent in Graphs 5-3 and 5-4 does not reach significance.

(c) F-Ratios

As can be seen in Table 5-15 the F-ratios were high for the fitting of a linear regression line, indicating that this type of analysis was not inappropriate.



GRAPH 5-3
Scanning time as a function of number of 4-letter units to be scanned. Angular letter condition, Task 5-3



GRAPH 5-4
Scanning time as a function of number of 4-letter units to be scanned. Round letter background condition. Task 5-3

The F-ratios from the regression analysis for the three groups were evaluated, and a summary table of the ANOVA main effects is shown in Table 5-19.

This analysis produced a significant group main effect ($p < .02$), and the control Ss clearly produced greater F-ratio, and were thus more consistent over the task than the patients. Subjects were more consistent in scanning rates in the round letter condition, than in the angular ($p < .01$). The lack of a significant interaction between G and C, showed that this between context difference did not differ between groups.

Relation Between Task Variables and Subject Variables:

Table 5-20 shows there was minimal correlation between Subject variables and the task variables, for the schizophrenic Ss. There was no relatively high correlation between years of hospitalization and the intercept values which may indicate a slowing of response with an increase in hospitalization. With the control Ss there was a slight tendency for the less intelligent Ss to perform better in the round letter condition. In contrast to Tasks 5-1 and 5-2, age appears to have little influence on subject performance on the present task. Interpretation of the significance of this however, is confounded by the fact that correlations in the previous tasks used a standardized RT based on a combined slope and intercept value.

Discussion:

In general task 5-3 was not singularly successful in discriminating between schizophrenics and normals.

Although there was a tendency for schizophrenics to perform more poorly than control Ss, few of the between group differences were significant. The schizophrenics were more likely to miss the target element than were the controls, and in the round letter context condition, the patients were significantly less consistent across trials, as measured by the F-ratio data derived from the fitted regression lines. The context variable also had little effect in the results, and none of the task variables correlated highly with the subject variables.

The principal difference between Task 5-1 and Task 5-2, and this final Task, is that the latter study utilized stimuli which were viewed in a continuous manner, while the first two tasks used essentially static displays. The continuous display offers no opportunity fora "second look", and this may make it more difficult for the S to monitor his own performance. The higher error rates of the schizophrenics indicate that these Ss were operating the apparatus more rapidly than they were able to assimilate the information. With this interpretation, the task demand characteristics become similar to the Continuous Performance Task which Kornetsky has used, and the results are consistent with his findings, that is, schizophrenics, when continuously viewing visual stimuli presented at a constant rate, have a lower probability of correct detection of target elements than controls.

Finally, it should be noted that this experiment lends itself to analysis in terms of linear components.

With the previous two tasks, the analysis of variance was completed on total RT at each level of each condition. Thus the results of this task do not permit the rejection of a hypothesis of group differences based on a combined response latency involving both slope and intercept. It is the finding however that increases in RT over increases in quantity of information are constant for both schizophrenics and controls, which is apparent in all three tasks, which appears to be the most significant.

CHAPTER SIX

THE SCANNING BEHAVIOUR OF SCHIZOPHRENIC SUBJECTS - THE SECOND EXPERIMENT:

> "(Patient 21) - My mind's away. I have lost control. There are too many things coming into my head at once and I can't sort them out.
> (Patient 6) - My mind is going too quick for me. Everything's too fast and too big for me (McGhie and Chapman, 1961; p.108)."

Introduction:

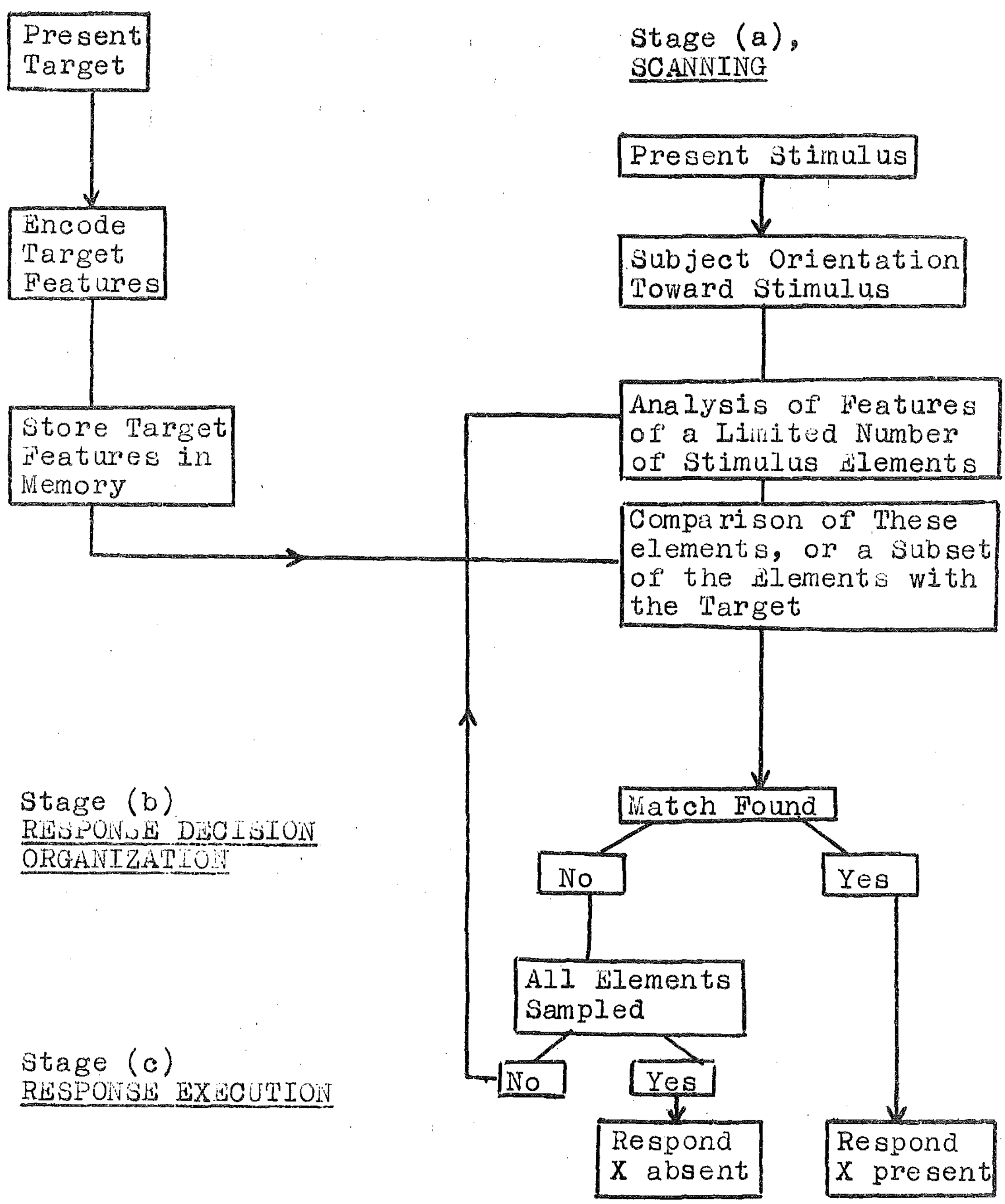
The design and aim of this second experiment with schizophrenic Ss, arose from consideration of some of the problems raised by the results of Experiment 1, (Chapter 5). The results of the first experiment with schizophrenics demonstrated that the effects of increasing the number of stimulus elements did not differentially affect the schizophrenics in relation to the normals, although the patients were consistently slower over all levels of stimulus complexity. This was not however true of the third task which involved search for a specific target, rather than a series of identity comparisons for a same-different decision, with a continuously moving rather than a static display. This may imply that schizophrenics can search as rapidly as normals for a predefined target element, whereas in the conceptually less concrete situation of scanning and categorizing for a "sameness" decision, they may exhibit a relatively slow response.

Several reservations must however be expressed: (a) the method of analysis, in terms of simple linear regression constants in Task 5-3, was not comparable with that of Tasks 5-1 and 5-2, and may have been less sensitive or meaningful (Neisser, 1963, himself notes that y-intercepts do not necessarily give exact information about time to execute responses), and (b) the relatively higher error rates for schizophrenics may have confounded the analysis of RT results because of possible different speed-accuracy trade off strategies of the two groups.

Accordingly it was decided to see if search for a predefined target also produced slow RT and whether any differences between groups resulted from variations in stimulus complexity. The previous experiment (Chapter 5) utilized chronic schizophrenics from both admission and long stay wards in an attempt to look at some of the basic subject variables which might influence results. The correlation analyses pointed clearly to one fact - the older, longstay patients who had been hospitalized for several years, had a slower RT than the younger newly admitted patients. In this present experiment it was decided to use process patients who had spent less than one year in the hospital since their most recent admission. This procedure was adopted primarily to make the possibility of confounding due to length of institutionalization (Strauss, 1973) less significant, and hence

Figure 6-1

FLOW CHART OF PROCESSES AND DECISIONS
HYPOTHESIZED TO OCCUR ON EACH TRIAL
OF THE TASK OF CHAPTER 6.



matching between groups of normals and patients more meaningful. Also, the first study had shown that the longstay patients had consistently slower response latencies than the admission ward chronics, hence if any differences were found with the latter group of patients (which was difficult to establish clearly due to the small numbers of such patients in the experiments of Chapter 5), then generalization to the longterm hospitalized chronics is not impossible.

In the present task, Ss were essentially required to search for a specified and constant target element amongst a randomly ordered set of background stimulus elements. A more detailed review of the task requirements on each trial is presented in terms of a general model in Figure 6-1, based on the literature outline presented in Chapter 1. The model can be broken down into three broad hypothetical categories.

(a) <u>Scanning</u>:

This is an overall term to encompass the selection of a limited number of elements which are subsequently compared with a representation of the target stored in memory. The processing is limited in that in some contexts with some types of stimuli (extremely complex, difficult to analyze or degraded stimuli) simultaneous analysis of features, and the subsequent encoding, probably depends on the extent to which it is necessary to use the same set of feature analyzers on the stimuli (Treisman, 1969; Marcel, 1970; Kelley and Doherty, 1968). This applies also to the comparison with the stored memorial representation of the target. In general processing capacity is enhanced either when many of the elements are identical (Marcel, 1970; Donderi and Zelnicker, 1970) or when the elements or inputs are very dissimilar, one from the other (Treisman 1969).

(b) Response Decision and Organization:

This process represents a constant decision making mechanism which is independent of the number of elements to be scanned.

(c) Response Execution:

Again, this is a constant process, akin to simple RT, which is not directly influenced by the number features or context of the stimuli.

This is a very general outline of the processes involved in successfully completing this task, presented in order to make potential explication of performance decrement more meaningful. Primarily the concern of the experimental manipulations lies with exploring deficiencies with Stage a, by varying stimulus complexity. This is further discussed below.

Method:

(a) Apparatus :

The experience of Experiment 1 allowed certain improvements to be made in the apparatus. The letter elements used as stimuli were made larger and clearer than the typed elements of the previous experiments. The single channel tachistoscope was replaced by an apparatus, more readily operated by the experimenter, and the Ss, (illustrated in Figure 6-2). A 47cm square aluminium box with a depth of 20.5cm was constructed with a 15cm square one way mirror situated 130cm from the front of the box, and 15.5cm from the left hand side of the box. A black canvas cover was arranged over and secured to, two brass rods extending 43cm from the top of the box, to cut down extraneous ambiance. The S operated the apparatus by pressing down a large switch located equidistant from either side of the apparatus, and 9cm from the edge of the mirror closest to the Subject. The stimulus card was placed on a tray 9cm beneath the mirror, such that the middle of the white stimulus square was directly below the midpoint of the mirror. The box was sloped by means of adjustable wooden legs to a position, (usually approximately 35^{o} from the horizontal) where the S could clearly see all of the white stimulus background. Pressing down the switch resulted in the initiation of the timing device, and of the illumination of two lights (60 watt, B.C. single-ended candle lamps) which permitted Ss to see the stimulus card. The S responded by making a vocal decision which operated a voice activated relay and stopped the digital clock in a manner identical to that described for Experiment 5-1.

FIGURE 6-2

APPARATUS USED FOR THE EXPERIMENT

OF CHAPTER 6

(b) Experimental Design:

The task used in this experiment required Ss to search through randomly ordered letters for a constant predefined target element, the letter X. The target was present however on only fifty percent of the trials. Two conditions of stimulus complexity were used, in the first all the background (i.e., nontarget letters) elements were the same, while in the second all the background letters were different. There was only one target element possible on each trial. Consequently four conditions were possible:

(1) Condition XS - The X target is present, all background elements identical.

(2) Condition NXS - The X target is replaced by another letter element differing from the other background elements, which are all identical.

(3) Condition XD - The X target present, all the elements are different in the background.

(4) Condition NXD - The X target is not present, and the background elements are different.

Half of the Ss received conditions XS and NXS first, and half received conditions XD and NXD first. Thus Ss received 40 stimulus cards with either all background letters the same, or all background letters different, with the presence or absence of the target being in a different random order of trials for each S; and then 40 similarly randomized stimuli of the opposite conditions.

(c) Stimuli:

The stimuli were presented on a 10 x 10cm white

FIGURE 6-3

SAMPLE STIMULI FOR THE EXPERIMENT
OF CHAPTER 6

The upper stimulus is from Condition NXD , while the lower stimulus is from Condition XS.

square of paper mounted on a 25.4cm x 14.5cm black cardboard card, 4cm from the bottom of the card and 2.5cm from the left hand side of the black card. The uppercase letter elements used were printed with Univers 16-point print, and were placed randomly in a 10 x 10 grid (each cell being 1cm x 1cm) using random number tables - using the same procedure described for Task 5-1. A sample stimulus is illustrated as Figure 6-3. The range of stimulus elements was from 3-60 inclusive, and included all the multiples of three between those limits - twenty stimulus cards for each of the four conditions - a total of 80 stimuli in all. The letters used for the background were randomly chosen from the set of the alphabet, minus the vowels, and target element X. The use of each letter was determined on a random nonreplacement basis. In conditions XD and NXD, where more than 20 background elements were needed, some letters were used more than once..

(d) Procedure:

The procedure for selecting schizophrenic Ss, and explaining the task to them was similar to that described in Chapter 5. All the schizophrenics were tested at the Psychology Department, Sunnyside Hospital, Christchurch, N.Z. All Ss were told:

"We are interested in finding out how quickly people can see things, and I am testing a wide variety of people to try and find out about this. I am going to show you, with this box arrangement, a card with a number of letters on it. Your task is to tell me as quickly as possible whether or not there is an X present amongst the letters. If there is call out "yes" as quickly as you can; if there is not, call out "no". Do not say anything else until you are ready to tell me whether the X is there."

The apparatus was then explained to the Ss, and the non schizophrenic Ss were told the nature and **purpose** of a control group. Half the Ss received conditions NXS and XS first, and half received XD and NXD first. Five practice trials, with each condition **were** given prior to commencing each half of the experimental session. The intertrial interval was determined by the S, who had complete control of the apparatus, once the new stimulus had been placed into position. Each experimental session lasted about 35 minutes, and was followed by administration of the Shipley-Hartford vocabulary scale to all Ss, and the Ullmann-Giovannoni rating scale to the schizophrenic Ss.

(c) <u>Subjects:</u>

Two groups of Ss, one of schizophrenic and one on controls, with 14 in each, were tested. The schizophrenic Ss were selected from the admission wards of Sunnyside Hospital. The diagnosis of schizophrenia was established using the criteria provided by the Astrachan et al. (1972) checklist of symptoms and was confirmed by the Psychiatrist responsible for the patient. Process schizophrenics

TABLE 6-1

MEANS AND STANDARD DEVIATIONS OF SELECTED SUBJECT VARIABLES:

	Schizophrenics	Controls
Age		
Mean	34.456	34.627
S.D.	11.519	13.559
Vocabulary		
Mean	26.428	28.643
S.D.	5.184	5.366
PDI		
Mean	14.039	
S.D.	11.109	
THL		
Mean	12.214	
S.D.	10.304	
PHL		
Mean	4.982	
S.D.	3.864	

(PHL = Length of Present Hospitalization (months); PDI = Phenothiazine Drug Index; THL = Total Hospitalization, months).

TABLE 6-2

PROBABILITY OF ERROR

CONDITION	SCHIZOPHRENICS	CONTROLS
XS	0.050	0.018
XD	0.187	0.025
NXS	0.004	0.000
NXD	0.007	0.000

were chosen for the experimental group on the basis of their case history, poor premorbid adjustment and prognosis. The Ullman-Giovannoni (1964) questionnaire was used to check the appropriateness of the process classification. The distinction between paranoid and nonparanoid chronics was abandoned for this study. No differences were found in the previous experiment between paranoids and nonparanoids.

Normal (nonpsychiatric resident) control Ss were chosen to match the sex, occupational status and age of the schizophrenics. There was no significant difference in age between groups ($t = 0.035$) nor in intelligence ($t = 1.071$) as measured by the Shipley-Hartford Vocabulary Scale. Details of the Subject groups are presented in Table 6-1.

Results

The probability of error for each condition is presented for both groups, pooled over Ss, in Table 6-2. The error rate was generally low, although it was higher for schizophrenics than for the controls, especially in conditions XD and XS.

The response latencies of all correct responses for each condition were pooled over Ss and the resultant mean data illustrated in Graph 6-1, and in Graph 6-2. The data was further collapsed by finding for each S the mean RT over each four successive levels of Factor N (Number of letters per stimulus), providing five mean response latencies per condition. For example, the first level of N for each condition was the mean of the RT to the 3, 6, 9 and 12 letter stimuli, the second level was the mean RT to the 15, 18, 21 and 24 letter stimuli, and similarly the third, fourth and fifth levels resulted from the averaged combination of four successive RTs. This procedure was adopted to avoid problems of missing data caused by the ommission of erroneous RTs, in the subsequent analyses described below.

Two ANOVAs were performed on the data after the means resulting from the collapsing of the initial results had been divided into two parts. The X-present conditions (XS and XD) and the X-absent conditions (NXS and NXD). This was done to facilitate interpretation of the data in terms of differences between groups on the XS and NXS conditions and XD, NXD conditions.

(a) The X-Present Conditions:

The mean and standard deviation of the untransformed RT to the stimuli of conditions XD and XS are presented in Table 6-3. This data presents much the same picture as that illustrated in Graphs 6-1 and 6-2. The significance of the trends of these results was tested using an 2 x 2 x 5 ANOVA with repeated measures on Factor C, Stimulus Background (the difference in RT to conditions XS and XD), and Factor N (Number of letters). The data was transformed using the Box-Cox transformation with $\lambda = -0.4$.

The ANOVA summary table (Table 6-4) showed there

GRAPH 6-1

Scanning time as a function of
number of letters to be scanned:
Conditions XS and XD

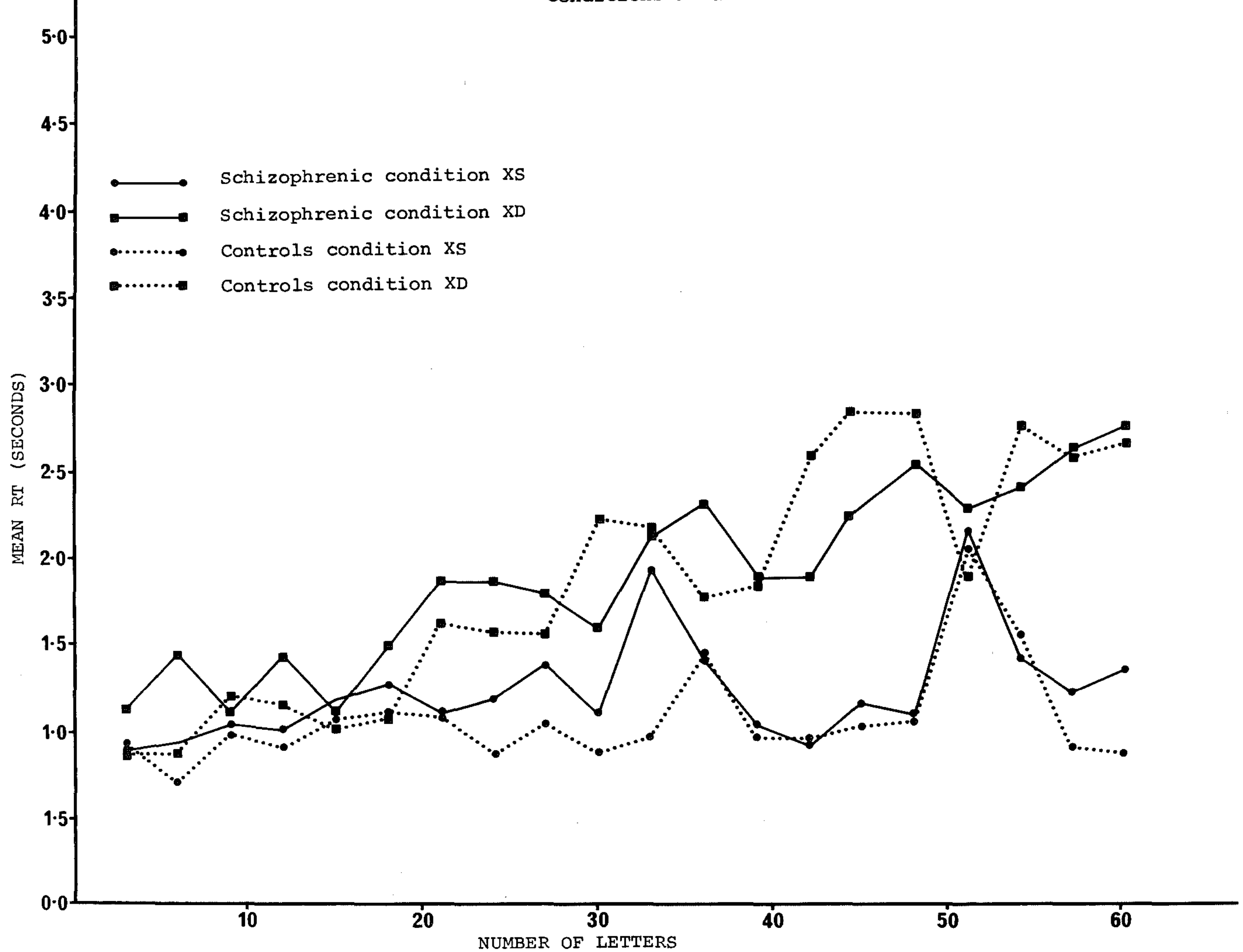


TABLE 6 - 3

MEANS AND STANDARD DEVIATIONS OF RT (SECONDS),
CONDITIONS XS, XD.

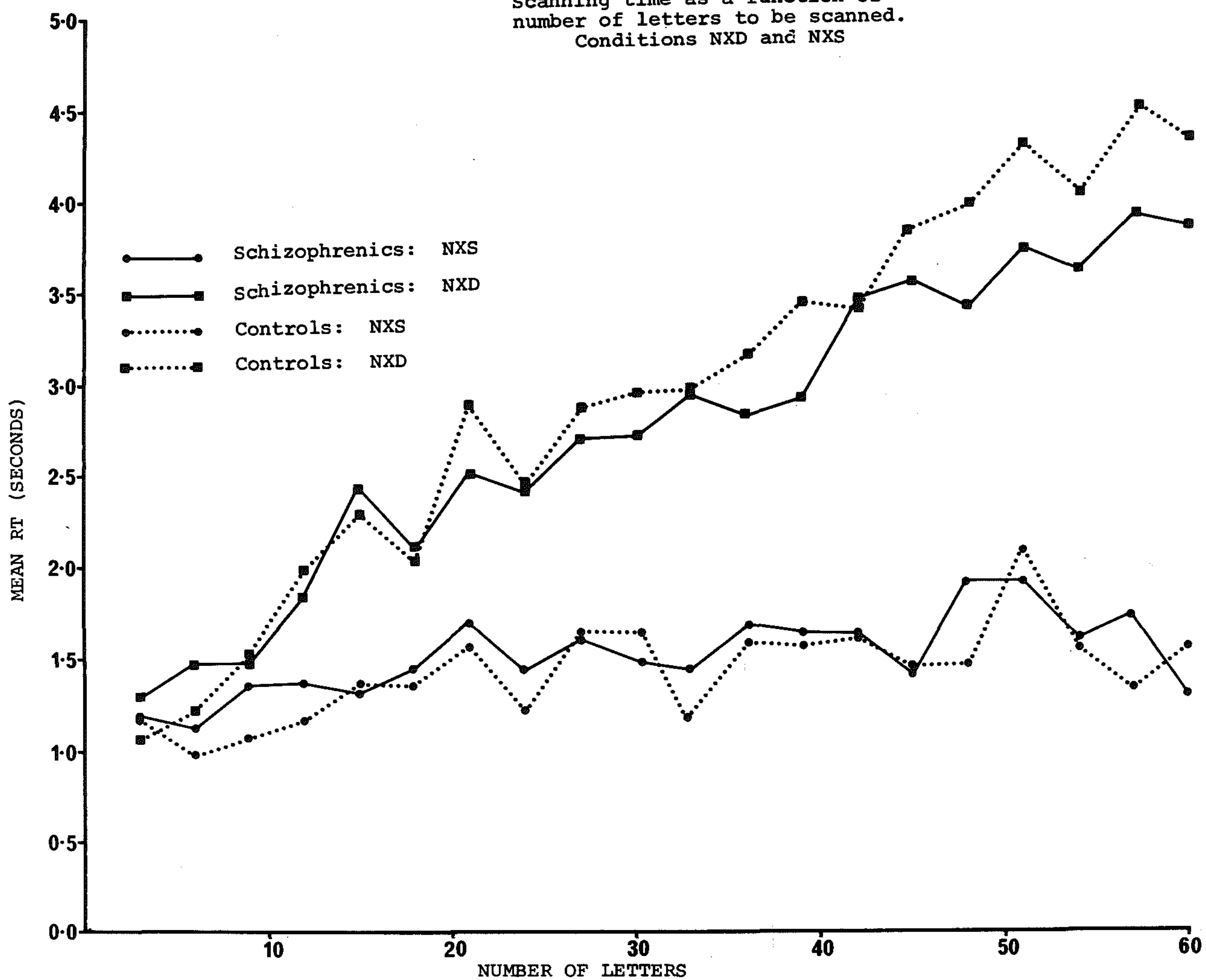
	Level of N		Controls	Schizophrenics
CONDITION XS	1	Mean	0.883	0.983
		S.D.	0.179	0.257
	2	Mean	1.048	1.188
		S.D.	0.303	0.459
	3	Mean	1.086	1.213
		S.D.	0.281	0.407
	4	Mean	0.998	1.081
		S.D.	0.033	0.261
	5	Mean	1.286	1.490
		S.D.	0.390	0.836
CONDITION XD	1	Mean	1.044	1.293
		S.D.	0.222	0.322
	2	Mean	1.329	1.558
		S.D.	0.297	0.645
	3	Mean	1.909	1.988
		S.D.	0.545	0.588
	4	Mean	2.495	2.112
		S.D.	0.847	0.775
	5	Mean	2.366	2.602
		S.D.	0.839	1.359

SOURCE	M.S.	df	S.S.	F	
Between Subj.					
Groups	0.792	1	0.792	0.564	
Subj. w. Groups	36.533	26	1.405		
Within Subj.					
Background (C)	24.069	1	24.069	206.223	**
CG	0.167	1	0.167	1.428	
C X Subj. w. Groups	3.034	26	0.117		
No of Letters (N)	15.687	4	3.922	59.002	**
NG	0.392	4	0.098	1.476	
N x Subj. w. Groups	6.913	104	0.066		
CN	4.054	4	1.013	15.763	**
CNG	0.267	4	0.067	1.038	
CN x Subj. w. Groups	1.671	104	0.064		

TABLE 6-4

ANOVA SUMMARY TABLE FOR CONDITIONS XS AND XD: **p< .01

GRAPH 6-2
Scanning time as a function of
number of letters to be scanned.
Conditions NXD and NXS



were no differences between groups (Factor G) either with absolute differences in RT, or in terms of scanning rates - the interactions CG and NG both being statistically non significant. The lack of difference between groups is illustrated by reference to Graphs 6-1 and 6-2.

The experimental manipulations of complexity however were successful. The strong C main effect ($p < .001$) demonstrates between scanning either many identical letters (XS), or many dissimilar letters (XD). Scanning rates were much slower for condition XD. Similarly as N increases, RT also increases ($p < .001$). The significant CN interaction ($p < .01$) is indicative of the trend clearly shown graphically, for the scanning rates of condition XS, and XD to be markedly different. The rate of increase of RT due to N with condition XS is far less than the increase rate for condition XD. Thus N had little effect on RT where the stimulus contained a large number of identical elements.

(b) The X-absent condition.

Table 6-5 shows the mean and standard deviations of the untransformed response latencies to the stimuli of conditions NXD and NXS. The significance of the data structure was analysed as before using a 2 x 2 x 5 ANOVA (with data transformed using the Box-Cox method $\lambda = -0.2$). The ANOVA summary table is presented in Table 6-6. Again there was no difference between groups (G main effect, $p > .50$). The CG interaction failed to reach significance, indicating the lack of difference between groups induced by differences in

TABLE 6-5

MEANS AND STANDARD DEVIATIONS OF

RT (SECONDS), CONDITIONS NXS, NXD:

Level of N			Controls	Schizophrenics
Condition NXS	1	Mean	1.081	1.263
		S.D.	0.243	0.343
	2	Mean	1.386	1.478
		S.D.	0.409	0.535
	3	Mean	1.502	1.549
		S.D.	0.364	0.621
	4	Mean	1.526	1.665
		S.D.	0.459	0.825
	5	Mean	1.633	1.635
		S.D.	0.495	0.598
Condition NXD	1	Mean	1.434	1.508
		S.D.	0.324	0.544
	2	Mean	2.368	2.326
		S.D.	0.637	1.115
	3	Mean	2.982	2.780
		S.D.	0.915	1.421
	4	Mean	3.648	3.372
		S.D.	1.176	1.627
	5	Mean	4.258	3.839
		S.D.	1.246	1.828

SOURCE	S.S.	df	M.S.	F	
Between Subj.					
Groups (G)	0.555	1	0.555	0.006	
Subj. w. Groups	94.597	26	3.638		
Within Subj.					
Background (C)	77.130	1	77.130	85.355	**
CG	1.712	1	1.712	1.895	
C x Subj. w. Groups	23.495	26	0.904		
Numbers Letters (N)	44.520	4	11.130	133.407	**
NG	1.152	4	0.288	3.452	*
N x Subj. w. Groups	8.676	104	0.083		
CN	10.003	4	2.501	29.665	**
CNG	0.042	4	0.010	0.124	
CN x Subj. w. Groups	8.767	104	.084		

TABLE 6-6

ANOVA SUMMARY TABLE FOR CONDITIONS NXS AND NXD

*p< .05
**p< .01

stimulus complexity between conditions NXS and NXD. The NG interaction was significant however, ($p < .05$). Relating this result to the graphical representations (Graphs 6-1 and 6-2) it can be seen that the interaction effect results from the faster RT of the normals to the smaller values of N, and faster RT of the schizophrenics to the larger N values, especially in condition NXD. By referring to the error rate data (Table 6-2) this result can be seen to have been due at least in part to a speed-accuracy trade off difference between groups. The schizophrenics have a higher probability of error in the XD condition, and hence are biased towards responding "no". This appears to have allowed a faster RT in the NXD condition.

As with the X-present data, the C and N maineffects are significant ($p < .001$). Hence RT increases as N increases, and there is a significant difference in RT between conditions NXS and NXD, the RTs in condition NXD being significantly slower. As the significant NC interaction ($p < .01$) indicates, scanning rates varied between conditions, with the rate of increase in RT being greater in Condition NXD than in condition NXS (Table 6-5).

(c) <u>Relationship between Task Variables and Selected Subject Variables</u>:

A procedure similar to that described in Chapter 5 was used to examine the relationship between task performance and subject attributes. For each of the conditions XS, XD, NXS and NXD a mean was found for

TABLE 6-7

CORRELATIONS BETWEEN SELECTED SUBJECT VARIABLES AND STANDARDIZED TASK VARIABLES

Schizophrenics

	Condition			
	XS	NXS	XD	NXD
Age	0.568*	0.683**	0.859**	0.840**
PHL	-0.009	0.168	0.305	0.307
THL	-0.085	0.077	0.568*	0.498
PDI	0.107	-0.191	-0.180	-0.117
Vocab.	-0.202	-0.479	-0.375	-0.413

Controls

	Condition			
	XS	NXS	XD	NXD
Age	0.562*	0.461	0.651**	0.513*
Vocab.	0.161	0.065	0.267	0.278

**$p < .01$

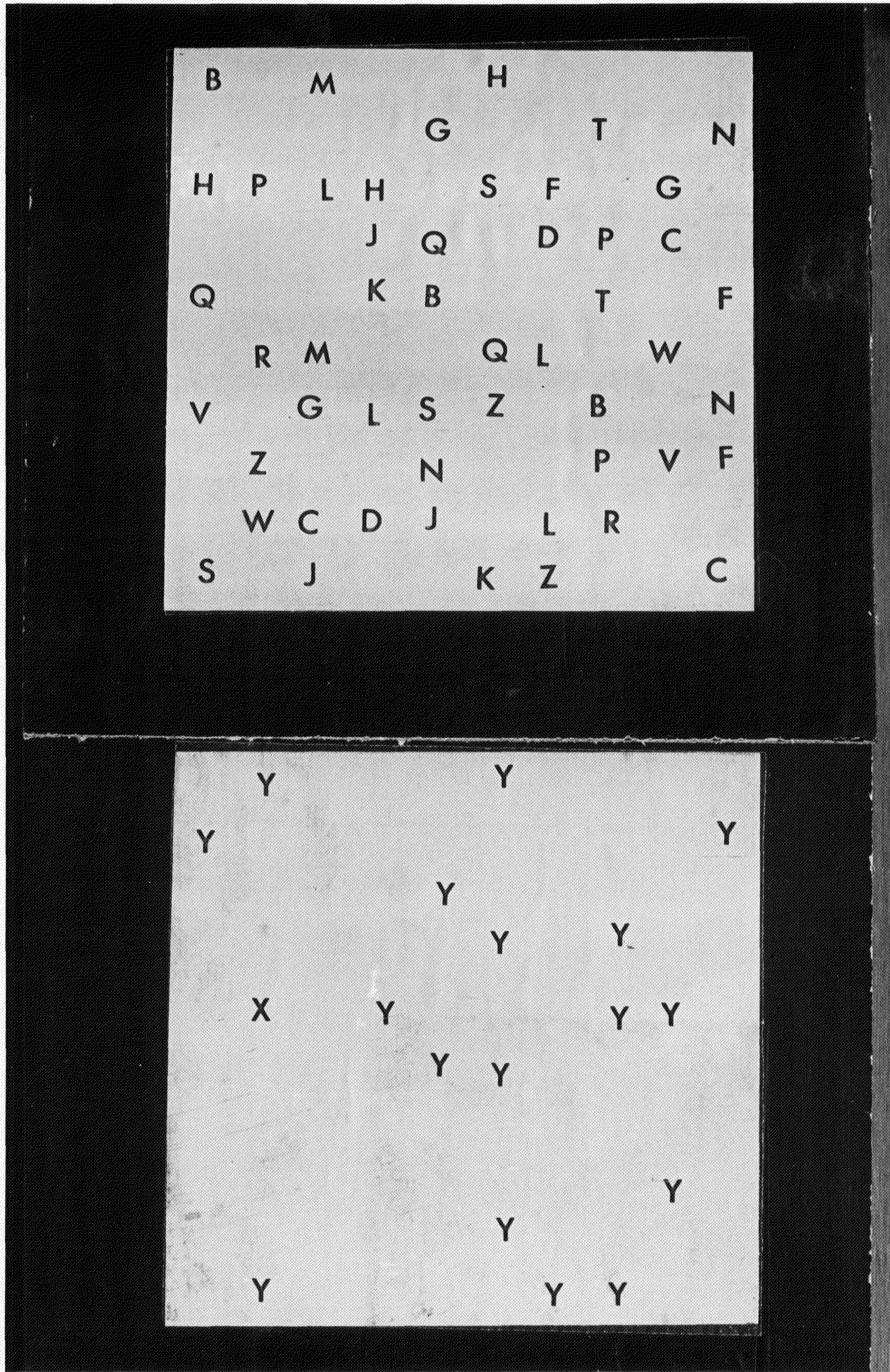
* $p < .05$

(PHL - Length of Present Hospitalization; THL - Total Hospitalization; PDI - Phenothiazine Drug Index).

each S, pooled over all levels of that condition. The grand mean for each condition was found by averaging the results of all Ss, and the individual S means were standardized to the normal distribution producing a z-score for each condition, for every S. The four resultant z-scores per S were then correlated with subject variables - age, Shipley Hartford Vocabulary Score, Phenothiazine Drug Index (PDI), length of admission on present hospitalization prior to testing (PHL) and total life hospitalization prior to testing (THL). The results are reproduced in Table 6-7.

Age is again clearly an important variable The degree of correlation between age and task performance, was high and positive, especially with conditions XD and NXD. As age increased mean standardized RT also increased. Hospitalization length tends toward a high positive correlation with RT although none of the correlations between PHL and task variables reach significance. There was a positive correlation between conditions XD and NXD and THL, with the THL - XD correlation reaching statistical significance ($P < .05$). A trend is evident then, in that the older patients with a longer hospitalization record produce slower mean RTs, especially when the stimulus complexity is increased (as it is between conditions XS, NXS and conditions XD, NXD).

Neither the PDI nor the vocabulary score provided a significant correlation with the task variables. As noted previously the PDI is of


B M H
G T N
H P L H S F G
J Q D P C
Q K B T F
R M Q L W
V G L S Z B N
Z N P V F
W C D J L R
S J K Z C
Y Y
Y Y
Y
Y Y
X Y Y Y
Y Y
Y
Y
Y Y Y

limited explanatory value; (Chapter 2) however the low correlation does imply here that high dosages are not significantly affecting schizophrenic task performance.

Conclusions:

The principal result of this experiment was clearly the lack of difference in RT between schizophrenics and normal controls on this particular task. With the exception of the one significant interaction (Table 6-6), between N and G in the X-absent condition, there were no between group differences in response latencies. Indeed this particular difference would appear to be the product of the slower scanning rate of the controls, coinciding with the higher error rate of the schizophrenics. These results largely confirm the findings of the first experiment using schizophrenic Ss, in that scanning rates do not differ between groups. In addition, with this task, the consistently slower times produced by schizophrenic Ss in the tasks of Chapter 5, did not appear, giving support to the view that such long response latencies are more typical of older patients with long histories of hospitalization. The schizophrenics used in this experiment had undergone lesser periods of hospitalization, while having a similar age range.

A simple correlational analysis showed that schizophrenic RT increased with age. This is also true of the normals to a greater extent in this study than in the previous experiment. Length of hospitalization also produces a trend towards slower RT, there being a positive correlation between THL and performance, although this result is confounded with affects due to age.

The data from this study show that differences between schizophrenics and normals do not necessarily appear when the amount of relevant stimulus input increases. The constant difference across complexity conditions (as found in the previous study) can be minimized by, (a) making response and task requirements somewhat less difficult by requiring Ss to search for a predefined target and to make a simple yes - no response, and (b) eliminating the long term, long stay chronic patients from the process schizophrenic sample. The implications of these findings will be discussed below in the overall conclusions to these studies.

CHAPTER SEVEN

CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH.

> "... a psychologist in the present state of knowledge must be either wrong or vague. We have tried being vague for twenty years and look at the situation we are in. I suggest that we had better try being wrong, but in somewhat more specific and intelligible terms (Hebb, 1952)."

When reviewing the literature of the last few years pertaining to schizophrenic deficit, it becomes obvious that some change in the orientation and the general level of sophistication of theory has occurred. The earliest studies, at Worcester State Hospital, over thirty years ago (Huston et al., 1937; Rodnick and Shakow, 1940) demonstrated the cognitive deficit of schizophrenic patients, and much of the research that has followed has succeeded in illustrating this deficit in certain specific and disjointed ways. Until recently also, there was an evident separation between theoretical cognitive psychology and its application to the study of schizophrenic functioning. The theories of McGhie (1970), Yates (1966a) and Payne (1960) lost much of their apparent validity because of their dependence upon the early Broadbent (1958) model of attentional processing. This model, which was of considerable significance when it was first propounded, has been gradually superceded and modified (Broadbent, 1971; Greenwald, 1972; Moray, 1959; Norman, 1969; Treisman, 1969). Acknowledgement of the limitations inherent in Broadbent's model has led to the undermining of the "defective filter" theory (Marshall, 1973) originally advanced by McGhie and his colleagues (e.g., Lawson, McGhie, and Chapman, 1967) and also by Payne (1960, 1966) in the guise of his overinclusion theory. Indeed Payne (1973) states that although the filter hypothesis has been useful and heuristic, it has not been empirically substantiated. The whole concept of overinclusion, due to its ambiguity, and its limitations in terms of the experimental tasks used (Price, 1968, 1970; Watson, 1967) has come to be regarded as obsolete.

A further weakness of the filter theory stemmed for the apparent reluctance of its adherents to explain how "distraction" is in fact distracting, or rather the nature of the irrelevant input, and the conditions under which it was most likely to cause performance deterioration. It is apparent for example, that it is not merely the physical presence of a "distractor" which causes deficit (Chapman, 1956a, 1956b; Chapman and Taylor, 1957), and possibly the potency of irrelevant input is increased by its "associational relationship" (Marshall, 1973) with the relevant stimulation. Part of the problem of understanding the effect of distraction has been the oversimplification of the "filter" and the subsequent neglect the fact that extraneous input must be processed to some extent for its irrelevancy to be established (Norman, 1969; Treisman, 1969).

Do increases in stimulus complexity result in differential rates of increase of RT for schizophrenics and controls? The answer to this question, as provided by the literature, is rendered less than conclusive by the confounding of response uncertainty with stimulus uncertainty (as Smith, 1968, defines these terms), in many studies. The differentiation of stimulus input, and response output stages implies that a distinction can be made between the various processing levels, and that total RT may be the cumulative product of a number of smaller time consuming steps (as in Sternberg, 1969). The theories of McGhie (1970) and Payne (1960) are concerned with rate of gain of stimulus information, and hence with stimulus uncertainty. Broen (1968) has concerned himself with response uncertainty, while Yates (1966a) has postulated a slowness of processing dysfunction which lies conceptually between the stimulus filtering, and response execution, stages. Evidence from the literature appears to support the view that response uncertainty influences RT of schizophrenics more significantly than does stimulus uncertainty, although there remains considerable difficulty in separating these two levels of complexity. For example, Venables (1958) found that while schizophrenics were slower over a range of stimulus complexity conditions, the deficit was constant over all levels. However, his later study (Venables, 1965) showed that schizophrenics' RT was more greatly slowed by increases in response complexity than were normals. Similarly, Court and

Garwoli (1968) found a constant slow RT over increasing levels of stimulus complexity. This result was contradicted by Slade (1971), but the differences between these two experiments may well lie in the difference of response demands between tasks. Marshall (1973), in an experiment which improved on Slade's technique, found both response and stimulus uncertainty to be important, but that response uncertainty was the more greatly significant.

The present experiments (Chapters 5 and 6) fit into the context of the above research. The tasks of Chapter 5 established that increasing stimulus complexity did not reveal a differential scanning rate between schizophrenics and controls. Task 5-1 and 5-2 showed however a significant RT difference, which was constant across stimulus complexity levels, for these two groups. It was evident however, from the Graphs of the experimental data for all three tasks (Chapter 5), that in fact the scanning rate of the schizophrenics tended to be slower than that of the controls. This effect however was minimal in relation to the differences between groups in constant response time. The results of the second experiment (Chapter 6) showed that the response decrement may be a particular characteristic of older, longterm patients, or of the response requirements per se. With regard to the latter point, Ss were responding to a predefined target in Task 5-3 and in the task of Chapter 6, while with Tasks 5-1 and 5-2, they were making same-different decisions. Principally however, the overall result was to show that stimulus complexity, when displayed in discrete stimulus trials, has as much effect on the RT of schizophrenics, as it does on that of the nonpsychiatric controls.

These results underline the fact that a clear distinction between response and stimulus uncertainty is necessary, if results are to be meaningfully interpreted in terms of information processing structures. More importantly however, there seems a need to quantify complexity so that it may be compared across the task, and across the conditions within a task. For example, it is necessary to know how stimulus complexity relates to response complexity and when the levels of each are equivalent - otherwise results of studies such as those of Marshall (1973), which compare and contrast these levels are meaningless. How then is stimulus complexity to be measured? Is there a simple linear function relating amount of input physically "fed into" the system to RT output - or is the relationship more complex than this? There is considerable and longstanding evidence for the view that RT is related to gross amount of physical input in a complex manner (Broadbent, 1971; Hick, 1953; Smith, 1968; Welford, 1968). Marshall (1973) used the conventions established by the Information Theorists (Attneave, 1959) although this type of formulation has been largely abandoned (Kahneman, 1973).

Another method of mensuration however remains - the development of a capacity theory along the lines postulated by Kahneman (1973) and Rabbitt (1968). In essence, such a theory suggests that the whole processing structure requires "effort" at all stages, and consequently a diminuation of this effort leads to performance decrement. The work with schizophrenia is beginning to militate against a deficit specific to the syndrome, or even specific to a processing stage. Within limits, there appears to be evidence for whatever processing stage is postulated to be the weak link in the information manipulating chain. The literature indeed suggests, as Marshall (1973) has proposed, that:

> "...schizophrenics' information processing capacities are defective compared with those of other subjects, and that this relative deficit is not isolated to any one aspect of processing. The specification of the extent of these difficulties will have to await further study, and CRT task seems well suited to the description of such defects (p. 420)."

The nonspecificity of the disorder then lends support to the capacity theory, in that such a formulation does not postulate a priori any particular "aspect of processing" as being deficient. In addition, a capacity theory allows strong comparisons of attention deficit between schizophrenic and other psychiatric disorders.

While the need for quantifying task demands is clearly evident, the method of fulfilling such a need is less obvious. Without the appropriate level of measurement being determined, capacity theories are of limited value. In the long term, quantification may come from more precise mathematical definition of the information transmission parameters, (as in the original Communication Theory) or else in terms of some physiological measurement (Kahneman, 1973). This will allow precise measurement of stimulus or response complexity, and the determination of total task demands. This appears to be the next, and most significant step in moving away from looking for a specific attentional process dysfunction, and towards an understanding of the total task demands as they interact with the schizophrenic S.

This thesis, as is all research in this area, was confronted by the major problem of defining subject groups. The use of the Astrachan et al. (1972) Checklist to establish the schizophrenic diagnosis, and the SSI to define paranoid status were relatively satisfactory. The measurement of chronicity however proved less tractable. In addition to conceptual problems in understanding the process-reactive distinction, the lack of a really adequate rating scale was very apparent. Neither the Phillips (1953) nor the Ullmann-Giovannoni (1964) scales were satisfactory, either in terms of their standardization and validity, or their applicability to New Zealand Ss. There is a manifest need for the development of a reliably constituted and validly predictive, prognostic rating scale for schizophrenics in Australasia, especially for research purposes.

The confounding effects of medication, although probably conservative (Chapter 2) also require some attention. Spohn (1973) notes the widespread use of phenothiazines, and the subsequent potential modification of schizophrenics' behaviour patterns. If drug effects to some extent determine somatic and psychological response levels, then some control of this factor would seem appropriate. This might be achieved by using drug free patients (probably an atypical sample), by witholding or withdrawing medication (which raises ethical problems), or by using some index of the medication the patients are receiving (Spohn et al. 1970, 1971) The PDI developed by Spohn et al. (1970) was used in this thesis to correlate drug dosage with task performance - although such indices have limitations, especially in the determination of equivalence between different phenothiazines. This simple measure of dosage level did not correlate significantly task performance (with the exception of Task 5-2). The most influential subject variable was age, which is a not uncommon finding with RT studies. Tasks 5-1 and 5-2 in particular showed that age was a more significant variable for schizophrenics than for the controls.

The constitution of the comparison group is another point which is often debated. Some authors (e.g., Cromwell, 1972) recommend that comparisons between psychiatric groups must be undertaken to determine the schizophrenia-specific deficit. The approach adopted in this thesis implies that the dysfunction is not syndrome specific, and may possibly be related to an overall reduction in attentional capacity. This reduction can be caused by a number of factors other than schizophrenia - e.g., sleep deprivation, low blood-sugar levels, high alcohol ingestion, senility, or depression - and would be manifest in a similar manner to schizophrenic dysfunction, if not to the same extent. Since ultimately the concern is to understand how schizophrenics approximate normal patterns of thinking, the comparison with only a nonpsychiatric "normal" control group is appropriate.

One of the charms, and one of the frustrations of thesis research is the way in which many lines of investigation, which can not all be followed up, suggest themselves during the course of experimentation. The earlier scanning studies, in particular Experiment 3-2, raised some interesting issues. For example, how is the position to commence scanning a random pattern chosen? It would appear that the preattentive scanning process which Neisser (1967) postulates may allow selection of the optimal position in the display to begin the search procedure. The parameters which bias selection of the first fixation could well be defined, using both recordings of eyemovements, and analysis of RT data.

The work with the chronic schizophrenics could well be extended by developing a more practical emphasis.

A key research question might well be - can measures of cognitive skills be used to predict job performance or relapse rates of schizophrenic patients? Hence future research may turn away from the search for the specific deficit, and towards the development of tasks with predictive utility. Indeed, a global capacity deficit theory engenders an attitude towards experimental design which may promote the establishment of tasks which can be used to consistently measure capacity, rather than a disjointed series of experimental paradigms which serve only to prove cognitive deficit exists. An information processing deficit in schizophrenia appears to be undeniable, but it is necessary to know what this means for the rehabilitation of patients, and their adjustment to community living. This thesis, as have many other studies, used discrete stimulus presentations (except with Task 5-3). Possibly however, the class of task best suited to measuring capacity would be the serial RT task. Such a performance measure requires continual concentration over long periods of time, with a "continuous pressure to respond" (Yates, 1966b), and these factors appear to have at least face validity in the measurement of attention capacity. The work of Kornetsky with CPT is an example of such a task. Another popular serial RT task has been card sorting (Marshall, 1973; Rabbitt, 1967; Slade, 1971), because of its simplicity of administration, and relative flexibility. The primary drawback has been the ambiguity of results because of differences in actual movement time between subject groups. Controlling for psychomotor speed may be necessary before the theoretical structure of this type of task can be clearly demonstrated in relation to schizophrenic patients.

Potentially the greatest area of research to which cognitive psychologists working with attention and schizophrenia might apply themselves, is in the evaluation of medication, and efficacy of dosage levels (Cromwell, 1972). Hence the major confounding of schizophrenia research can be exploited and used as the centre of study. The extended use of tests of attention dysfunction over a patient's hospitalization, and the relating of results to the ameliorative effects of medication, and to job performance, would constitute a major future research project.

In summary, the experience of the research of this thesis, if not the outcome of the experimentation per se, inclines one towards the view that schizophrenics do not have necessarily a specific attention deficit, which can be defined in the context of a hierarchical cognitive processing structure. That is, one of the stages in a Sternberg (1969) type chain of processing has not collapsed. The notion of a particular defect appears more appropriate to a model of organic brain damage. Rather, the dysfunction is global in character, and can be conceived of as a reduction in the capacity to expend processing energy. To use Rabbitt's (1968) analogy, the reason why a small computer is less efficient than a larger computer in handling a complex computational problem, is not merely because of some specific malfunction, but is a direct result of the computer size or capacity. The conceptualization has advantages in that it suggests research on the overall measurement of schizophrenic attentional capacity, and the relation of this to therapeutic and employment outcomes. The major drawback is that such a theory tends towards the illdefined pronouncements of the dynamic motivational and drive theorists. If this disadvantage can be overcome, and an adequate measure of capacity developed, then cognitive psychologists may continue to find they have much to offer to research in this area.

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